HARDWARE.....SOFTWARE.....AT HOME.....IN BUSINESS

computing today

JANUARY 1982
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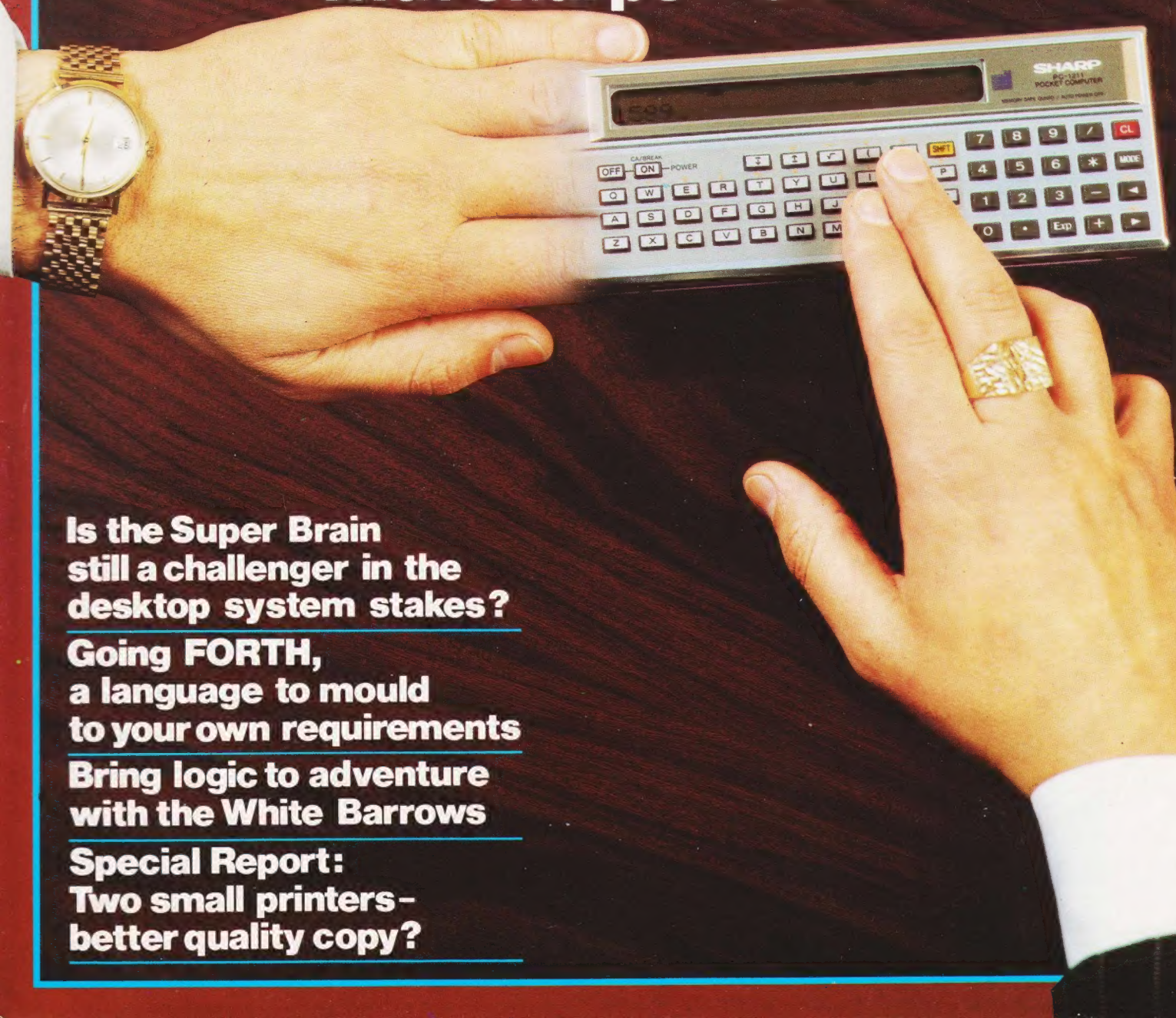
70p

FOR A PERSONAL APPROACH TO MICROCOMPUTING

Programming for the hand-held revolution with Sharp's PC1211



Is the Super Brain still a challenger in the desktop system stakes?

Going FORTH, a language to mould to your own requirements

Bring logic to adventure with the White Barrows

Special Report: Two small printers – better quality copy?

ingenious!

..that's the only word to really describe the superb Genie microcomputer system, the home computer which is compatible with the TRS 80, and ideal for all micro – enthusiasts, especially the committed hobbyist.
Genie has now been upgraded to Genie I, incorporating all of the original, excellent features, but with the addition of:

- Extended BASIC, including RENUMBER and SCREEN PRINT.
- Full upper and lower case, flashing cursor and auto-repeat on all keys.
- An internal SOUND UNIT to add a new dimension to your own programs.
- A MACHINE LANGUAGE MONITOR, with Display, modify, enter and execute (with break points) facilities.

Genie I has all of this, plus the built-in cassette deck, 16K RAM, 12k ROM with BASIC interpreter, full-size keyboard , an extremely wide range of new and updated peripherals, and literally 1000's of pre-recorded programmes available. Yet, almost unbelievably, the price of Genie I is even lower than that of the original Genie.

Ingenious for business

The Genie II is a major breakthrough for small business computers. Harnessing all the advantages of Genie I, including low price, Genie II adapts perfectly to commercial functions with the following features:

- Numeric keyboard
- Four usable, definable function keys.
- Extension to BASIC
- Basic business commands
- Fully expandable with the same peripherals

New!...12" Monitor

Now, a choice of 2 monitors giving a clear easy to read image. The updated EG101 has a new green phospher tube.

New!...Expander

An updated Expansion Box (EG 3014) is a major feature of the new Genie I system, and unleashes all its possibilities, allowing for up to 4 disk drives with optional double density. It connects to a printer, or RS232 interface or S100 cards. There is 16k RAM fitted and it has a new low price!

New!...Printer

The EG 602 printer can be connected to the Genie either through the expander or directly into the computer using the Parallel Printer Interface. It is a compact unit, with an 80 column, 5 x 7 matrix print-out, operating quietly and efficiently at 30 characters per second.

Disk Drive

As well as the obvious advantage of mass storage, the addition of the disk system to the Genie means much faster access to other languages and full random access file handling. Up to 4 of these 40 track drives can be used on a system.

SPECIAL TECHNICAL GENIE HOT – LINE ON 0629 4995

for all your technical advice and service back-up on any aspect of the Genie system direct from the experts!

For full details and demonstration of Genie I, Genie II or advice on any aspect of the system, either call in to your local dealer, or write directly to the sole importers at the address below.

LOWE electronics

Chesterfield Road, Matlock, Derbyshire DE4 5LE.
Telephone: 0629 4995. Telex: 377482 Lowlec G.

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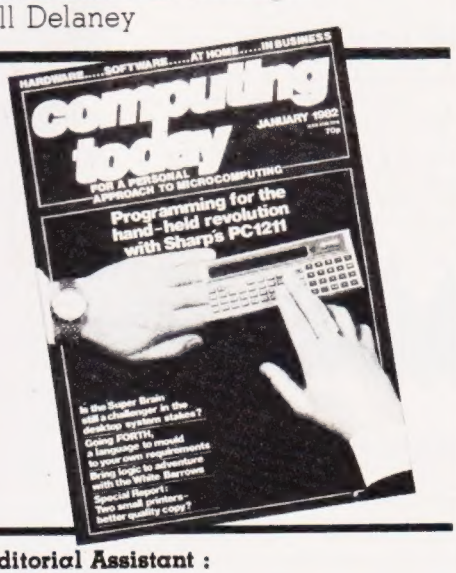

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Computing Today is constantly on the look-out for well written articles and programs. If you think that your efforts meet our standards please feel free to submit your work to us for consideration.

All material should be typed. Any programs submitted must be listed, cassette tapes and discs will not be accepted, and should be accompanied by sufficient documentation to enable their implementation. Please enclose an SAE if you want your manuscript returned, all submissions will be acknowledged. Any published work will be paid for.

All work for consideration should be sent to the Acting Editor at our Charing Cross Road address.

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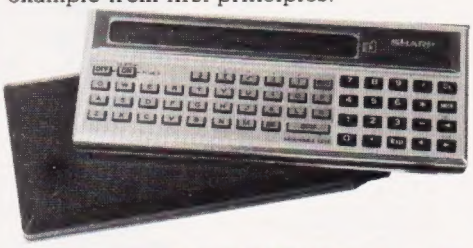

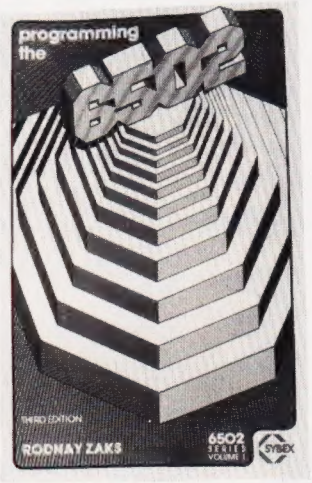

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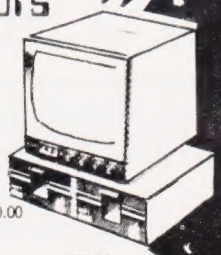
... Monitors & TV's ...



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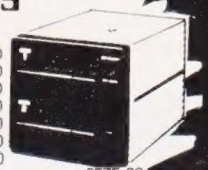

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Although we are the largest Sharp micro dealer outside Japan we do give personal service – ring Alec or Graham Knight if you have a query and we will do our very best to help. Ring, write or telex for our latest software lists and hardware offers. We accept ACCESS, BARCLAY, VISA, MASTERCHARGE etc – ask about our credit and leasing arrangements.

happy computing, 73,88,10-10,

Graham Knight GM8FFX

P.S. I recently had lunch with Timothy Raison M.P. at the House of Commons and along with other fellow RETRA members we are trying to get computers talking to each other via the new legal CB radio. Details in the newsletter.

P.P.S. Remember to add Maggie's VAT to all prices.

NEW SHARP LANGUAGES

KNIGHTS WEE PASCAL commands include: insert/delete lines, find/insert string, move, replace string, VAR, PROC, FUNC, ARRAY, IF . . . THEN . . . ELSE, PUT, INP, OUT, OR, XOR, AND, NOT, REMAINDER, RND, INCREMENT/DECREMENT VARIABLES. Supplied with four programs – ideal for PASCAL beginners. On tape for MZ-80K £20

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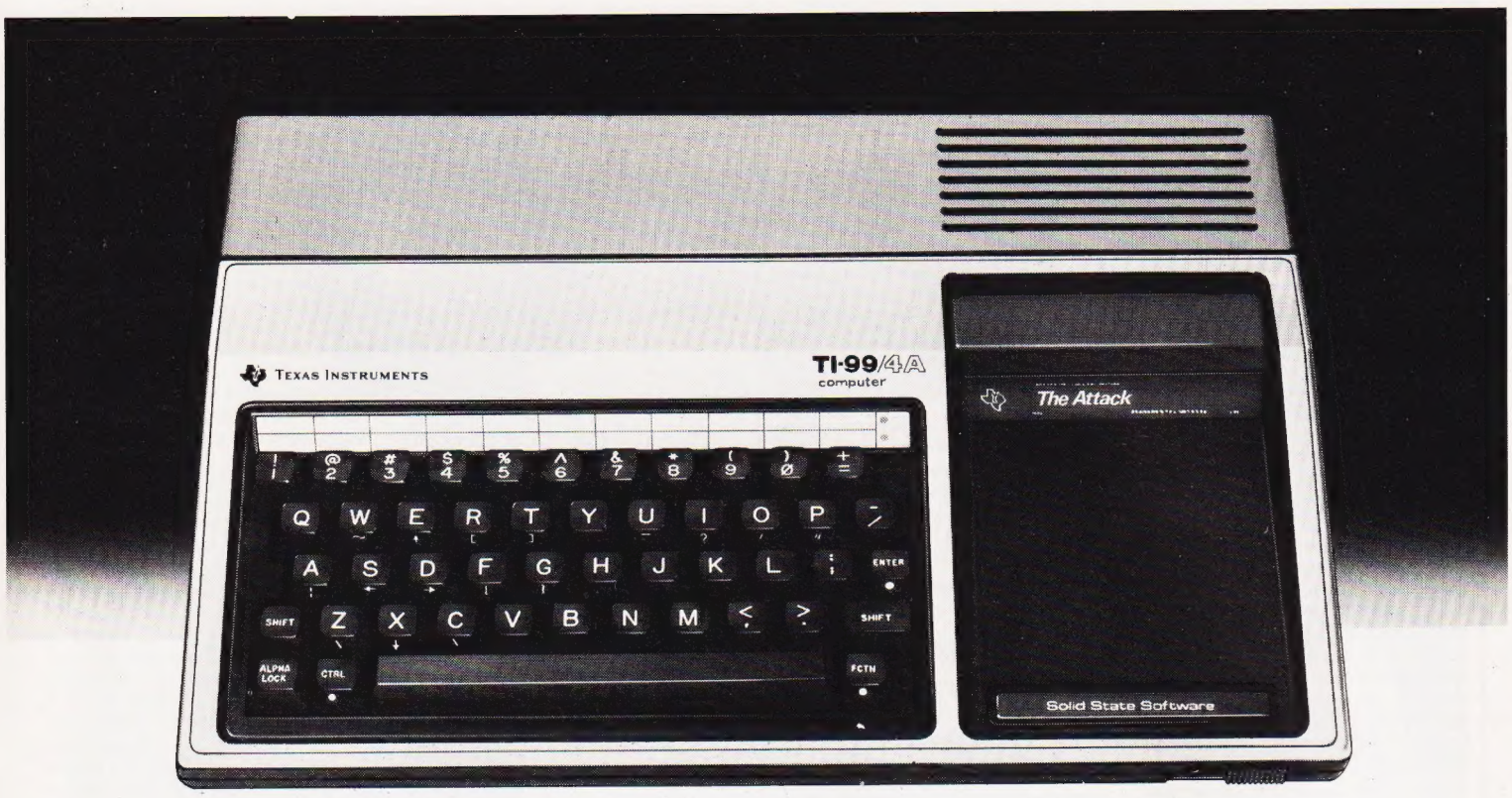

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ZILOG CHIP IN

Into the Single Chip Computer stakes comes a new entry from Zilog designated the Z8671. Based around the Z8601 CPU it has an on-chip BASIC, debug and monitor software and 128 bytes of RAM. Expansion possibilities are up to 62K but usually only 4K would be required for most applications. The chip also features four eight-bit I/O ports, an asynchronous communications port and the two counter timers allowing the possibility of a two-chip personal computer! Clive is probably already plotting his next step in reducing the ZX82 to a single chip at this point! The in-built BASIC is a subset of Dartmouth BASIC, the great granddaddy of them all and, unusually, supports the USR function. For more information on this amazing little device drop Zilog a line at Babbage House, King Street, Maidenhead, Berks SL6 1DU.

BOOKLIST FOR FREE

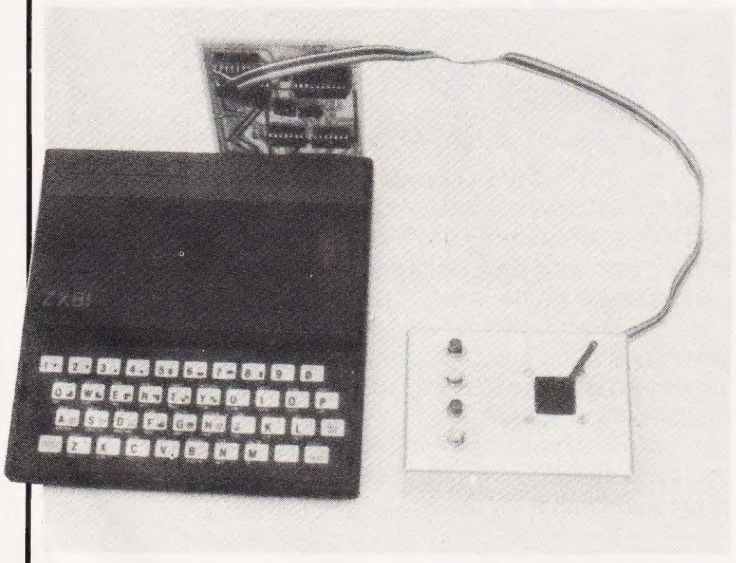
March Communications have published their second Computer Booklist. The 20-page A5 booklet is available free from the company at 7 Victoria Terrace, Liverpool L15 5BH and contains details of over 200 titles all of which are available direct from the company.

SOUTHWEST GO NORTH

From November 30th all of Southwest Technical Products' UK operations are to be centralised on a new base at 12 Tresham Road, Orton Southgate, Peterborough PE20 0SG. Their new telephone number will be 0733-234433 and it is hoped that with the new central location and better communications, all support and marketing operations can be streamlined and improved. Please address all information requests to the new site after the above date.

ORIENTAL AGREEMENT

Clive Sinclair's ZX81 will be in the shops by Christmas. Not here, or in Europe, or even in the States, but in Japan. A marketing deal was signed last week between Sinclair and Mitsui and Co, a large Japanese trading company. The current product for export is the ZX81 and the 16K RAM pack with the printer to follow soon. Needless to say the manual has been translated into Japanese, one can only hope that we have made a better job of it than they make of some of their translations from Japanese to English!



I/O, I/O IT'S OFF TO PORT WE GO

The great bolt-on goody race has started once again and, needless to say, the system for which the battles are being fought is the ZX81. First contender, judged by the fact that it got through the letter box before the other one, is Technomatic's User Port. Costing a mere £11.50 it offers an eight-bit input and an eight-bit output port controllable from BASIC or machine code. A book of suggested applications costs 40p or you could bolt on some of the recent projects in CT. The second contender is the DCP Peripheral Pack which features 4K of extra RAM and a pair of ports. This offering costs £37.95 inclusive, and comes with an instruction and software booklet. Details can be obtained from Technomatic at 17 Burnley Road, London NW10 and DCP Microdevelopments at 2 Station Close, Lingwood, Norwich NR13 4AX respectively.

WELCOME BACK!

Those of you with an eye for a lovely lady might well think they recognise this delightful example clutching a new slimline 8" drive to her.....er.... chest. Connoisseurs of the female form may well think back to the November issue of this magazine where an extremely similar figure made an appearance on page 12. The burning question is, is it the same lady? The only people who really know are HAL Computers, purveyors of the new drive which is manufactured by Tandon. The drive is only half as thick as previous models enabling you to fit four units where you previously had two. The unit is available in single or double-sided versions and requires only 5 V and 24 V for operation. For more information on the product (and the true identity of the lady), contact HAL at 57 Woodham Lane, New Haw, Weybridge, Surrey KT15 3ND or ring them on 0932-48346.

MICRO PAY OUT

Somebody was bound to do it, a commercial payroll package for the ZX81. Designed for companies with less than 30 employees the software requires a ZX81 with a printer and an extra 16K of RAM; hardware cost £170, software cost £25! A training package is available if required and software updates can be obtained when the Chancellor juggles the tax. For more information write to Hilderbay Ltd, 8-10 Parkway, London NW1 7AA or ring them on 01-485 1059.

MICROFAIR TWO

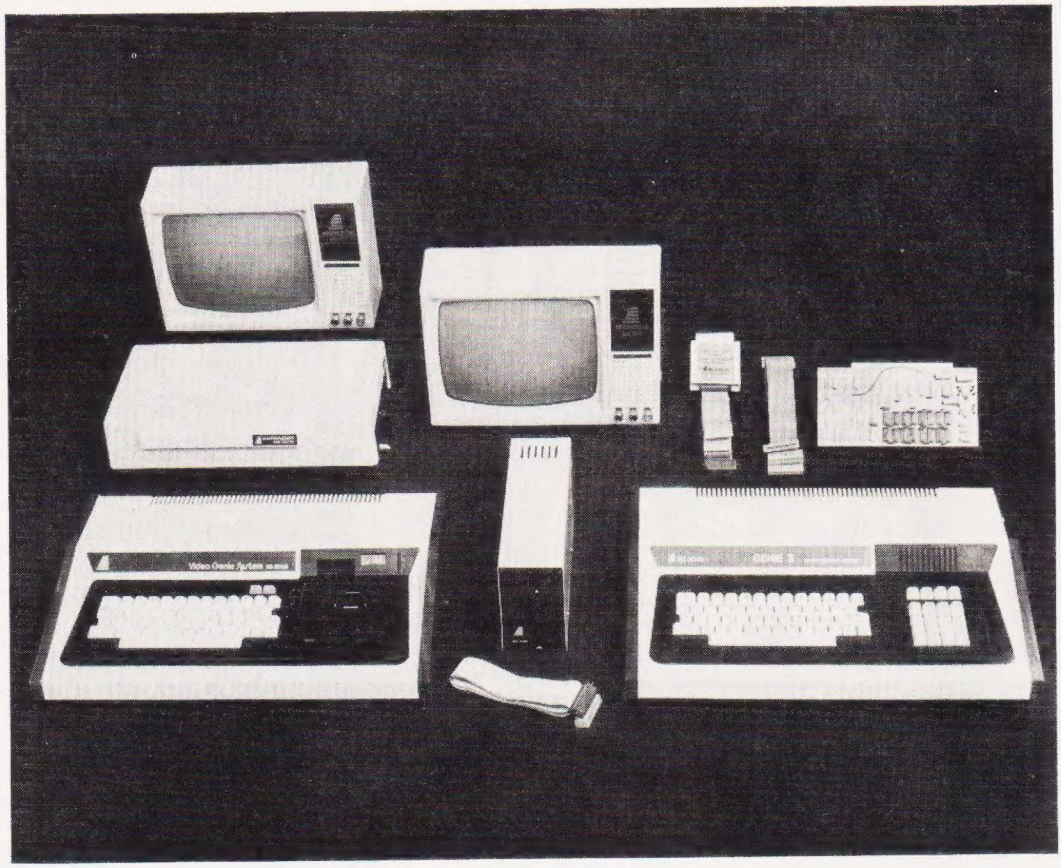
No sooner had we published a report that the second ZX Microfair was to be held in the Spring than we heard that the date has been brought forward and it will now take place on Saturday 30th January. Times have been extended, 10.30am to 8.30pm, and there will be twice the available space. The venue is still the Central Hall Westminster and although the cost to exhibitors has been kept down, it is expected that some nominal charge for entrance will have to be made. For more information contact the organiser, Mike Johnson, at 71 Park Lane, Tottenham, London N17 0HG.

SOUNDING OUT

A group of ex-ICL engineers have set up their own company specialising in microcomputer add-ons. The first product is a sound board for the Tangerine at £44.85. Based on the General Instruments AY-3-8910 device it features an on-board amplifier and speaker and comes complete with data sheet on the device and a manual on how to operate it. For an extra £10 you can have a second GI chip fitted onto the board for double the noise-making capability. Their next offering is planned to be a high resolution colour graphics board and the expected price is around £170. For further information contact Bulldog Video at 52 Nash Square, Birmingham B42 2EX or at 13 Highway, Crowthorne, Berks. Telephone enquiries should go to 0299-266143.

ALADDIN'S ASSISTANT ▶

No sooner had we received the full details of the Genie 2 than we heard about the Genie 3! To take these events in order, the Genie 2 is basically an upgraded version of the original Genie with the same 12K Microsoft BASIC but with a 1.5K extension including full upper and lower case, auto repeat, screenprint, dumb terminal routines and networking capability. The integral cassette deck has been replaced by a numeric and cursor control keypad with four user definable keys. All the existing expansion options can be fitted and a range of business software has been developed by Tridata specifically for the Genie 2. The even newer Genie 3 is a single console system with 800K of disc, 64K of RAM and has the facility to run both Level 2 BASIC and CP/M. It performs this amazing trick by changing the screen format to suit each of the operating systems. At the time of going to press no price was available but an informed estimate would be around £1200. For more information contact the UK distributors, Lowe Electronics, at Chesterfield Road, Matlock, Derbyshire DE4 5LE or ring on 0629-2430.



NAKED SPEECH

Using a custom technique based on compression of real speech, Triangle Digital Services are offering their Instant Speech chip set for £39.00. No micro is needed (switch closures will do just as well) and the users required vocabulary can be encoded in 48 hours. A basic set of words in an 'average' quality is included in the set and extra ROMs may be added as required. A complete Eurocard system can also be purchased for £97.06 and this can be interfaced to a micro through an RS232 interface or a parallel port. For information on the product drop them a line at 23 Campus Road, London E17 8PG or ring on 01-520 0442.

ALGOL WITH CLAWS

An interpreting version of ALGOL for the TRS-80 range has been produced by Crab Software of 2 Pondwick Road, Harpenden, Herts AL5 2HG. The 9K implementation is based on Nicklaus Wirth's ALGOL W and runs on 16K Model 1 or Model 3 systems. Included in the facilities are a screen editor, user definable I/O, variable names of any length, recursive functions and a whole host more. The package will cost £75 and is supplied on cassette with a user manual; more information from the company at the address above.

NORTH OF THE BORDER

Scotland is to get its very own Computer Show. The exhibition will be held at the Albany Hotel in Glasgow between the 16th and 18th of March 1982. The show is aimed at the first time buyer and a number of local firms have already booked stands; the established user and system operator are also catered for. Further details from the organisers, Crouchmead, at 42 Great Windmill Street, London W1V 7PA or ring on 01-437 4187.

X RATED LANGUAGE

If your system is 8080 or Z80 based and running under CP/M 2.2 or North Star DOS you can take advantage of a new FORTH implementation called X-FORTH. Currently at a special price of £40 it complies with the 1979 standard and includes such utilities as a debugging aid, screen editor and a macro assembler. The same company is also bringing out what Dr Dobb's Journal called 'a revolutionary word processing system' named Amethyst. The package is totally CP/M compatible and sounds exceedingly interesting. Parts of it are written in C and they even throw in the C compiler for the price of £200. For further information contact AIM Research at 20 Montague Road, Cambridge CB4 1BX.

TAKING APPLE TO TASC

A compiler for the Apple has been introduced by the same software team that wrote the Applesoft Interpreter. The new Microsoft TASC compiler is designed to work directly with the interpreter and offers the added facilities of increased speed, program linking and true integer arithmetic. The compiler writes the object code directly onto disc as it compiles, making it capable of dealing with very large programs. For more information contact Pete & Pam Computers at Waingate Lodge, Waingate Close, Rossendale, Lancs BB4 7SQ or ring them on 0706-227011.

PRESTEL ON PAPER

Claimed as a 'first' in the field of Prestel hard copy units is a modified version of Electrographic's EG800 matrix printer. The printer's character set is altered to suit the Prestel character and graphics set and a 1K page buffer is fitted. Printing takes place at 80 cps and can be on plain listing paper or continuous roll as required. Data is fed into the system through an RS232 interface at 1200 baud, the standard Prestel transmission speed. For information on this, or any of Electrographic's range, contact the company at Printinghouse Lane, Hayes, Middx or ring on 01-573 1826.▼

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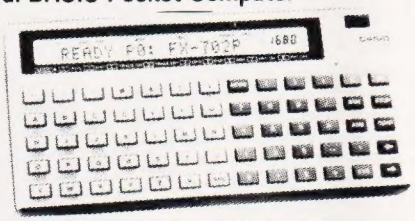

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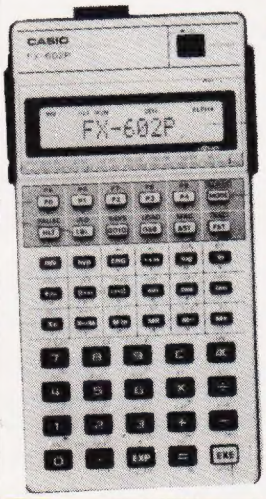

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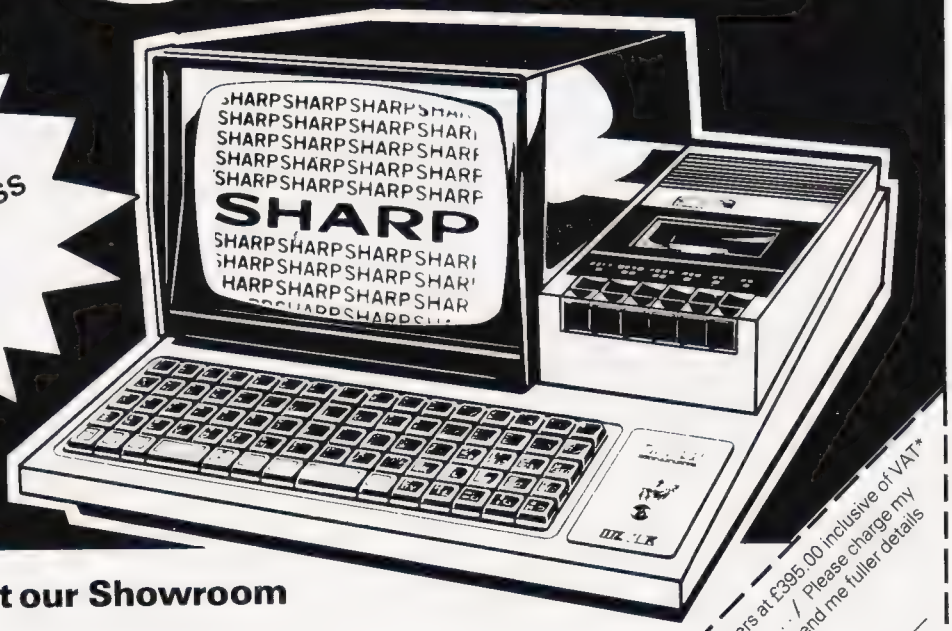

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APPLE BEARS FRUIT

The Apple III system has been officially re-launched in the UK just two days before the distributors, Microsense, became Apple Computer (UK) Ltd. The system is now based around a 6502-compatible, custom-built CPU which can address up to 256K of memory. A single 5¼" disc is fitted along with 128K of RAM, serial and parallel interfaces, and a six-bit D to A converter. The keyboard is expanded from the Apple II and that rather dangerous switch has been moved well out of the way. A variety of graphics modes is available and the screen format is basically 80-column, although high resolution (560 by 192) is available for business displays and the like. The 'basic' system with a video monitor, a wadge of business software and the new Sophisticated Operating System will sell for around £2700. If the expansion capability of up to four discs is not sufficient then, for a further £2256, you can purchase the ProFile, a 5¼", 5Mb Winchester disc which is Apple's latest product. Most of the available Apple II software will run on the 'III' under a special emulation package but the more successful products, VisiCalc and the like, have been re-written to make use of the added facilities on the 'III'. For technical product information and prices, contact your local Apple dealer or write direct to Apple Computer (UK) at Finway Road, Hemel Hempstead, Herts HP2 7PS. ▶

◀MORE STORE

LSI Computers of Woking, those regular visitors to these pages with their small business systems, have recently upgraded their M-Three machine to take Shugart's 8" Winchester. Available in five or 10Mb capacities running under CP/M, the prices start at £5,300. LSI have also taken on a distribution agreement for the new OKI IF800 colour graphics system. Based on Z80A with 64K of RAM it also features a built-in printer and twin 5¼" discs giving 560K of storage. Interfacing is through an RS232 serial port and you can also plug in ROM cartridges with up to 4K of program. Pricing will be between £4,500 and £5,000. Further information from LSI Computers, Copse Road, St Johns, Woking, Surrey GU 21 1SX or ring on Woking 23411.

ON THE MOVE

Almarc, the Vector Graphic people, have upped and offed to new premises in Nottingham. Their new abode is at Great Freeman Street, Nottingham NG3 1FR and they can be contacted on 0602-52657.

DISPENSING WITH THE PROBLEM

One of the major problems with manual documentation systems is that when overworked they tend to become somewhat illegible. One of the best examples of this can be found in your local High Street where the overworked pharmacist has to produce dozens of labels for the various drugs being dispensed. A company called Microscript has introduced an automatic label printer for dispensing chemists. Capable of handling up to 1,500 different drugs and preparations with up to 300 combinations of dosage, it is based on an Apple with twin discs and a printer. The pharmacist simply enters the abbreviated codes for the drugs and their dosages and the computer searches out the full names and directions from its memory. A facsimile label is then produced on the screen and, if correct, can be printed onto a custom-designed label. The system can also automatically produce warning notices where required and the Apple itself can be used for other purposes such as stock control. For an illustrated information sheet on the product contact Microscript at 6 Pavilion Parade, Wood Lane, London W12 0HQ or ring them on 01-743 9000.

GRAB DEM BYTES ▶

A right quartet of companies have conspired to make sure that the data you capture with one company's portable terminal can interface through a second firm's unit operating under a third company's software running on yet another company's computer! The terminal is the MSI 77 which can be carried around picking up information such as stock levels or order quantities. This is plugged into an interface unit designed by Mektronic Consultants which in turn connects to a Sharp PC 3201 computer running under Sumlock Software's latest package. If all that has got you confused, I'm not surprised. See your local Sharp dealer for help and advice!

APIARISTS ARRIVAL

The American VDU makers, Beehive, have signed a distribution deal with Terminal Display Systems of Blackburn. The full range will be available and for technical information you should contact TDS at Philips Road, Whitebirk Industrial Estate, Blackburn, Lancs BB1 5TH. The latest terminals all employ micro technology and offer system emulation and full editing facilities. Details soon in our Buyer's Guide

BUSINESS NEWS

FINDE YOR SPELING MISTEAKS

Exidy have introduced a dyslexic's dream, a disc-based dictionary for their word-processing package. The vocabulary consists of some 20,000 words but can be expanded as required to about 50,000; this is limited by the available disc space. The speed of operation is around 5,000 words per minute but there is a minimum time requirement, so short documents will not necessarily process faster. Assuming that you have the hardware requirement of a disc-based Sorcerer the program will cost you £195 and is available from Liveport at The Ivory Works, St Ives, Cornwall or ring 0736-798157 for your local dealer's address.

CHARACTERS IMPRINT

The possibilities for cracking puns about the formation of a new software publishing house, Caxton, are almost endless! But would one dare make such remarks about people like Dashing Dave Tebbutt, recently Editor of our rival PCW, or Alan Wood, ex of Digitus and Micro Focus, or even Bill Barrow lately of Data Logic? Well, one would, but the photograph they sent us makes them look so much like a certain Organisation that the words freeze in one's vocal tract! Their basic function in life is to establish and promote British software, initially for CP/M and Apple but this will doubtless expand. Indeed, they have already set up a cross-distribution deal with Microsoft in the States where they will distribute Microsoft's CP/M range and Microsoft will distribute Caxton's product in the US. Alan Wood's old company are acting as Techinical Consultants for product verification and the intent is to ensure that each product will be crashproof and completely international. For information contact David Tebbutt at Caxton, 10-14 Bedford Street, Covent Garden, London WC2E 9HE.

WORDS ON WORDS

The latest publication from the National Computing Centre is a book entitled 'Introducing Word Processing'. Priced £8.50 it details the various types of system, the software and necessary background information. The book also shows that the users are as important a link in the chain a the hardware, something few purchasers seem to consider. The publication should be available from specialist bookshops or direct from the NCC at Oxford Road, Manchester M1 7ED.

MODEL = PRICE

Memory Computers have introduced a new, low-cost, small business computer called the Memory System 2000. Priced at £2000 it is Z80 based with 60K of RAM, twin 5¼" discs giving 400K of storage under CP/M and an integral keyboard/VDU. The recommended printer is the Centronics 737 which they will supply for £400 although other models are available, notably a daisywheel type for word-processing. Language and software support consists of BASIC with FORTRAN, COBOL, Pascal and an Assembler available as extras. The system will be marketed through a national network of 22 distributors who will also supply a variety of software packages. For details contact Memory Computers at Britannia House, 960 High Road, N Finchley, London N12 9RY. ▼

SURVEY RESULTS FROM US

The results of the sixth annual small business computer survey in the USA have just been published by Management Information Corporation. The results are based on the responses of over 470 companies using some 600 small business systems and nearly 1,000 peripherals running 245 software packages. A total of eight small business computers were awarded the MIC Certificate of User Commendation together with 26 peripherals and six software packages. Copies of the report are available from MIC at 140 Berklay Center, Cherry Hill, NJ 08034 for $22. Please mention this magazine when contacting them, or indeed any of the overseas companies mentioned in these pages.

FEEL YOUR VDU ▲

The ultimate in tactile computer interaction must be the touch screen VDU. A new add-on for DEC VT100 terminals allows the user to retrofit a touch panel onto the screen giving some 30 touchable areas. Developed by a Massachusets-based company called Interaction Systems the product is being brought in by Peripheral Hardware of West Molesey, Surrey and C W Cameron of Glasgow. Alternative formats are available for the Lear Siegler ADM 32 and 42 terminals and can be custom made for most other types. The quoted price of DEC unit is $945 and the current UK price can be obtained from either of the two companies. Peripheral Hardware are at Armfield Close, West Molesey, Surrey and C W Cameron is at Brunfield Road, Giffnock, Glasgow.

The MICRO-PROFESSOR ...

MICRO-PROFESSOR is a low-cost Z80 based microcomputer which provides you with an interesting and inexpensive way to get into the microprocessor world. MICRO-PROFESSOR is a microprocessor learning tool for students, hobbyists and personnel. It is also an ideal microprocessor educational tool for teaching in schools and universities. Besides, MICRO-PROFESSOR is more than a learning tool. It provides a wide range of applications such that you will be surprised at its amazing power.

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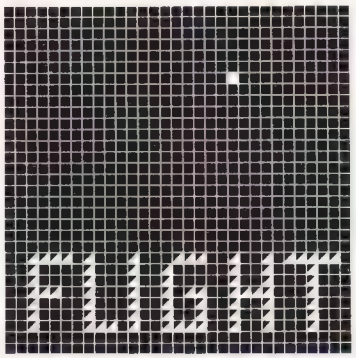

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Dr G J Marshall

If you are involved in Computer Aided Learning or are considering producing software for schools then you should know about PILOT.

PILOT is a language for computer-assisted learning (CAL). It is a language for writing programs which, when run on a computer, can help the user to learn a particular subject. PILOT programs start a dialogue in which the user participates. Responses are assessed and rewarded if they are correct or, typically, if they are not correct another chance to respond is offered. Thus, the type of CAL offered by PILOT programs is the same in principle as that available from a programmed text. However, when using a computer, successful responses can be rewarded more emphatically with imaginative use of graphics, just as further responses following a wrong answer can be encouraged more effectively. Additionally the opportunity to play with some facility possessed by the computer can be offered if a section is completed successfully or rapidly.

PILOT was designed at the San Francisco Medical Centre in 1973. The original version is referred to as Core PILOT. In its early years it was used in a more or less pure standard form as a flexible language for producing interactive dialogues designed for learning purposes. Subsequently, the language was extended by Professor G Gerhold and L Kheriaty to give what is known as COMMON PILOT. This extended version is a sufficiently powerful and flexible language to deserve to be called an 'author language' for CAL.

Languages for CAL enable microcomputers to be used as educational tools and to be used in such a way that learning is fun. They can be used like this not only in schools and colleges, but also in the home. However, CAL programs written in PILOT are rather greedy for storage, and as a rough estimate, a program which produces five minutes of dialogue requires about 8K of storage.

Core PILOT

The Core PILOT language has six types of instruction. Each instruction starts with a key letter which indicates its type, and the key letter is followed by a colon. An instruction starting with a 'T' is an output instruction. When executed, it causes the text following the colon to be printed out. An instruction starting with 'A' is for input, and on execution it causes an input from the keyboard to be accepted. The letter 'M' signals the start of a match instruction, the execution of which causes a flag to be set to 'Y' or 'N' respectively, as the characters following the 'M' match or do not match the most recently accepted input. The instruction starting with 'S' causes program execution to stop.

Instructions may be made conditional by starting them with 'Y' or 'N', in which case they will only be executed if the state of the match flag agrees with the initial conditional letter.

A simple example program to illustrate the use of these instructions, which gives an arithmetic test, is:

```
T :  WHAT IS THE RESULT OF 2+3*4?
A :
M :  14
YT:  FOURTEEN IS CORRECT
NT:  NO. THE ANSWER IS 14
S :
```

This program causes a question to be printed and accepts an answer which it matches with the correct answer before printing an appropriate comment on the answer given.

The remaining instruction is a jump instruction and commences with a 'J'. When followed by a zero, it causes a jump to the preceding input instruction, as illustrated by the following program.

```
T :  WHAT IS THE LARGEST COUNTRY
     IN AFRICA?
A :
M :  SUDAN
YT:  YES, THAT'S CORRECT
YS:
NT:  NO. TRY AGAIN
J :  0
```

```
WHAT IS THE LARGEST COUNTRY
IN AFRICA?
?    NIGERIA
NO. TRY AGAIN
?    SOUTH AFRICA
NO. TRY AGAIN
?    SUDAN
YES, THAT'S CORRECT
```

The program requests inputs repeatedly until the correct answer is given.

A jump forward is achieved by using '*' as a program marker, and then an instruction such as J : 2 causes a branch to the second program marker forward from the jump. This is illustrated by the next program which converts figures to words.

```
T :  ENTER THE FIGURE 1, 2 OR 3
A :
M :  1
YJ:  1
M :  2
YJ:  2
M :  3
YJ:  3
T :  YOUR INPUT WAS NOT AS REQUESTED
S :
*T :  ONE
S :
*T :  TWO
S :
*T :  THREE
S :
```

COMMON PILOT

An examination of the example programs already presented reveals a number of shortcomings. For example, the first program expects the answer to be given in figures as '14', but there is nothing wrong with the responses 'FOURTEEN' 'Fourteen', and 'fourteen'. In the second example, the program can loop forever if the correct answer is not given, It is probably desirable to maintain a counter, so that after, say three wrong attempts the correct answer is given and the program proceeds. Additionally, it is useful to be able to deal with spelling mistakes in answers, for unless spelling itself is being tested repeated rejections of slightly incorrect spellings can be very discouraging.

While some of these problems can be overcome in Core PILOT, the extra features of COMMON PILOT are designed to overcome these and other shortcomings. There are computational instructions which start with 'C' and then take the same form as BASIC assignment statements, for example:

```
C :  SC=SC+1
```

Thus, powerful processing features are available in COMMON PILOT. Matching instructions can include lists of possible answers, such as:

```
M :  4 ! FOUR ! FOUR ! four
```

where '!' represents the OR operator. They can also include the items of an

answer using the AND operator (&) so that the items can be given in any order and recognised as a correct answer, for example:

```
M :  young & blonde & pretty
```

This facility gives alternative ways of recognising incorrectly spelt answers, eg:

```
M :  separate ! seperate
```

or

```
M :  sep & rate
```

Also, it is easier to create conditional instructions because a condition can be directly attached to any instruction so that it is only executed when the condition is true in the manner illustrated below:

```
T (NT<3) : Still wrong. Try again
```

This does not give a complete listing of the features of COMMON PILOT, but a program segment to illustrate the use of the features that have been described is given below.

```
C :  SC=Ø
C :  NT=Ø
T :  WHICH COMPUTING MAGAZINE
     IS BEST?
A :
M :  COMPUTING TODAY ! CT
C :  NT=NT+1
YT:  VERY GOOD. IT CERTAINLY IS.
YC:  SC=SC+1
YJ:  NEXT
J(NT<2):  Ø
T :  YOU'VE HAD TWO TRIES.
     IT'S COMPUTING TODAY
NEXT C:  NT=Ø
T :  WHICH COMPUTER HAS ROYAL
     CONNECTIONS?
A :
M :  DAI ! Dai ! Di ! DI
C :  NT=NT+1
YT:  YES, IT'S THE LADY DAI
YC:  SC=SC+1
YJ:  ON
J(NT<3):  Ø
T :  SORRY, BUT IT'S TOO AWFUL
     TO TELL YOU
ON C:  NT=Ø
```

Summary And Conclusions

Core PILOT is a small language and I tend to feel that it is easier to write CAL programs in BASIC than with it. However, COMMON PILOT is a much more powerful language and because of its careful design it is more suitable for CAL than BASIC. PILOT programs tend to be rather long if they are to produce substantial dialogues. Also, they are about as easy to read as assembly code programs! However, with practice, lively dialogues can be produced that stimulate the user to follow them and learn from them.

For further reading, **High-level languages for microprocessor projects** by D Taylor and L Morgan (NCC, 1980) includes a section on PILOT, while the now-defunct **Computer Age** carried a series on PILOT by Gerhold and Kheriaty in issues 3, 4, 5 and 8.

Implementations of PILOT are available for all the popular processors. It is actually not too difficult to implement PILOT yourself using BASIC as the implementation language.

Figure 1 gives a flowchart for such an implementation of Core PILOT. While I do not recommend such an implementation for serious CAL work since, among other shortcomings, it would be extremely slow, it does make an interesting project. Additionally, it reveals that there is nothing 'difficult' about system software in general and translators in particular since a language translator is just another computer program.

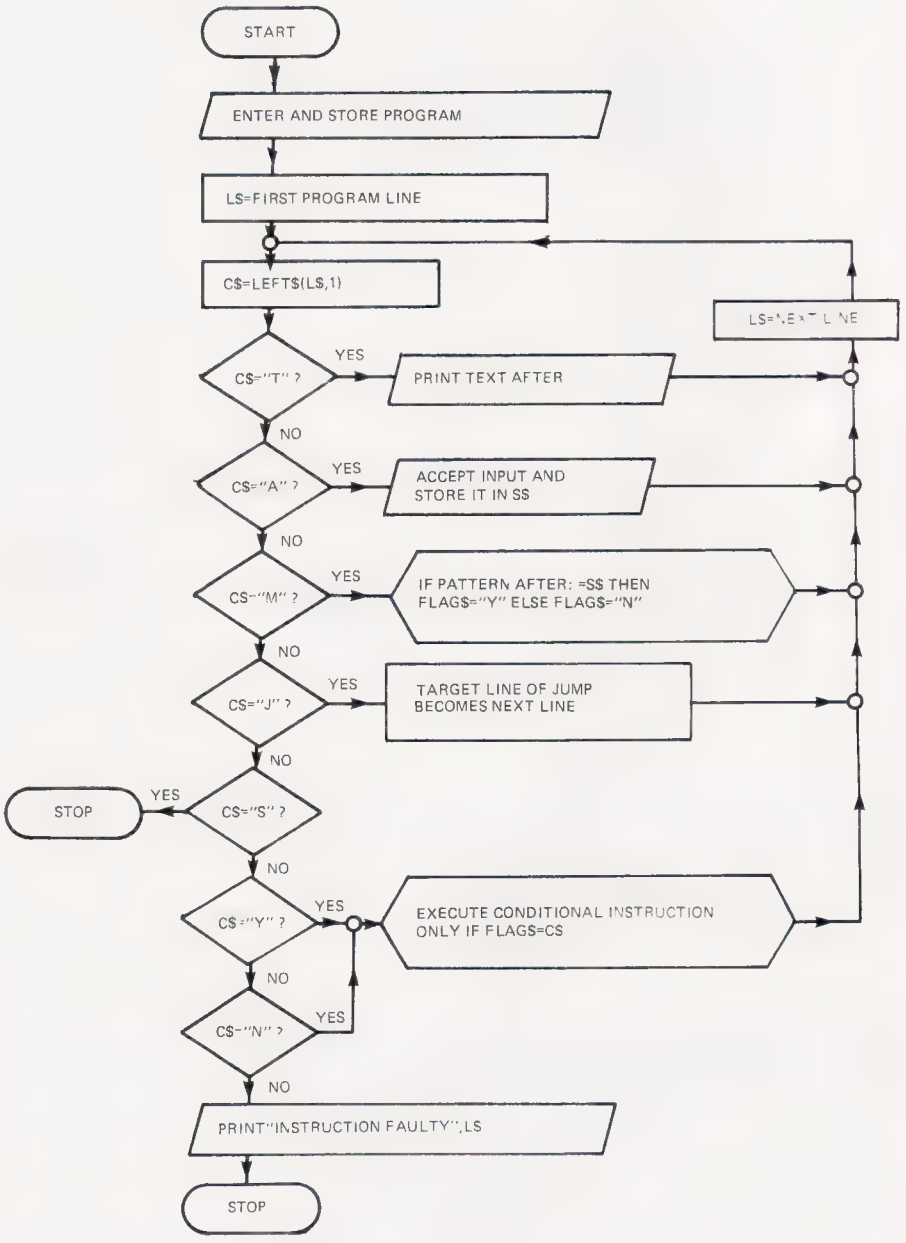


Fig. 1. This flowchart gives the basic requirements for an implementation of Core PILOT.

NEXT MONTH

GRAF RITE WRITES GRAPHICS!

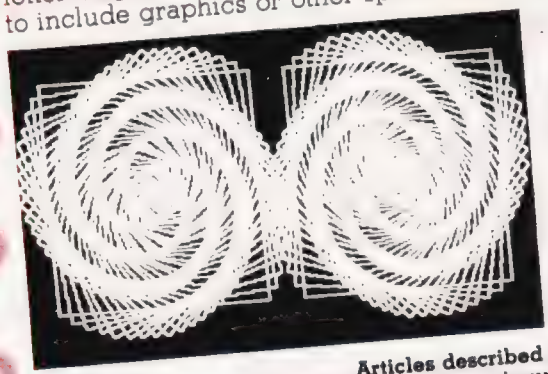
User definable graphics are normally associated with systems that contain large amounts of memory. In next month's issue we show you how to define your own characters on the Acorn ATOM system — one of the smaller machines on the market. The techniques are applicable to many other systems that use a defined area of memory for the screen and, although the program is mainly written in machine code, it is fully documented to make conversion easy.

USING GRAPHICS

A set of features on the Apple, Tandy/Genie and Sorcerer show how to get the best out of each of these systems as far as graphics is concerned. Each of the articles will include numerous hints, tips and program examples on how to get that little bit extra out of your system. Ideal for the beginner or even the experienced user who wants a better understanding of this aspect of programming.

PRINT YOUR OWN POSTERS

If you want to print something ***really*** big the only way to do it is on paper. POSTERS is a utility program which allows you to choose the size that you want the characters and then prints out your message on the printer. The heart of the program is a suite of subroutines that define the shapes of each letter or groups of letters and this can be expanded to include graphics or other special symbols.



GRAPHIC DETAILS

We pay another visit to the hidden secrets of systems that feature graphics in their character sets. Revealed, among the pages, will be the full character set of the UK101 together with its American counterpart, the Superboard. If you are program which allows you to choose the size that you want the characters and then prints out your

Articles described here are in an advanced state of preparation but circumstances may dictate changes to the final contents.

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Mike James

It's over a year now since we first looked at this twin CPUed desktop computer. To find out how it fared during its twelve months trial you should read on.

About a year ago the Intertec SuperBrain caused something of a stir. A full microcomputer system — 64K of memory, two double-speed Z80s, a 24 line by 80 character display, built-in twin mini-floppies and CP/M all in one case — and all for less than £2000! At the time it was a breakthrough in terms of value for money, but now it's time to look again. Since the SuperBrain was introduced, the world has changed — now memory costs £8 for 16K and there are machines with similar specifications all in one box, eg the Tandy Model III. If the SuperBrain still has anything to offer it must be on performance as well as price.

The History

Computer manufacturers have always put as much as they think that the average buyer can afford in to one package. So early on, you bought a CPU with as much memory as you could afford; later, memory became so cheap that it wasn't worth making an issue of it and a full 64K became standard. The Intertec SuperBrain was the first successful machine to bring all of the features of a complete personal computer together in one self-contained package, looking like a slightly large VDU. As it was normal practice at the time, the advertising campaign started a while before any machines were available and after a number of delays (reported to be due to the change from slim-line 5¼" drives which didn't work, to standard size drives which did) the production model SuperBrain appeared. Its impact was immediate — no matter how good it was, it was ideal for many applications — and a large and rambling dealer network sprang up. This situation persists today. Intertec, unlike Apple, have never got round to appointing a single main distributor — perhaps they're not very interested in the UK. This has made getting any definitive information about Intertec's present or future plans difficult, to say the least! Following this rather confused start we now have a range of Intertec products in support of the SuperBrain.

A User's View

Before we deal with the technical details of the machine, let's examine the impression that the SuperBrain gives in use.

The overall configuration of the SuperBrain can be seen in the photographs. The main points to notice are the large full keyboard, the 12" CRT screen and the pair of 5¼" floppies mounted vertically to the right of the screen. Around the back you find two standard sockets for serial devices. This means that the SuperBrain can only handle serial printers, ie not the standard 'Centronics' type. However, it does mean that the machine can be used as a VDU if required — but more of this later.

In my day-to-day usage of the SuperBrain I have found it pleasant enough. Let me itemize in some detail particular features I like and dislike.

The Keyboard: This is precise with no bounce, and has a sensible upper case lock which gives upper case on all the character keys and lower case on all the number keys unless one of the shift keys is pressed. The only complaint that I can level against the keyboard is that it lacks a repeat key. (I know that this is available as an optional extra but it's such a little extra that it should be standard.) A special feature of the keyboard is the two red keys to the far right and left of the bottom row. Pressing either one of these results in nothing, it's only when you press both simultaneously that the system resets itself and tries to reload CP/M. This simple single feature has saved Intertec from being responsible for the loss of countless millions of bytes of data. As any one who has used an original Apple keyboard will tell you, it's all too easy to hit one reset key by accident — but to hit two is much more difficult!

The Display: The VDU display is stable and clear. With an 80 by 24 screen it's suitable for business applications but why, oh why, did Intertec use a format for lower case characters without true descenders? Just in case you don't know what a descenders on the SuperBrain means that a screen full of lower case characters looks very strange with letters all over the place. It's true that you get used to it, but it is a little difficult to explain why the text is so difficult to read to a first time computer user. As in the case of the keyboard, it is possible to make good the defect by buying an add-on, but having true descenders is a basic requirement for a business computer and should not be treated as an extra.
add-on, but having true descenders is a basic requirement for a business computer and should not be treated as an extra.

The Disc System: The two mini-floppy drives are standard units. The format is either single-sided double-density giving 350K, or double-sided double-density giving 700K total storage. At first I was a little worried about using such high performance discs. On the whole, I would rather have a lower capacity coupled with high reliability and, after the trouble I have had in the past with single-sided single-density discs, I feared the worst. But I am pleased to say that the disc system has proved reliable and, in time, I might even be converted to the viewpoint that double-density works! One small point to mention is that the drive motors run continuously. Generally speaking, it is current practice to leave the motors of 8" drives running, because they take about two seconds to come up to speed but 5¼" drives are sometimes set up to run continuously and other times to turn on and off as required. The pros and cons are that intermittent operation reduces diskette wear and average noise levels, but increases drive wear and access time. Whereas continuous operation increases wear in diskettes and average noise levels, but reduces drive wear and access time. My personal preference is for intermittent operation so the SuperBrain does not entirely satisfy me.

The Software: For a non-technical user the only thing that makes the SuperBrain ***really*** special is that it's all in one box! The Super-

SUPERBRAIN REVISITED

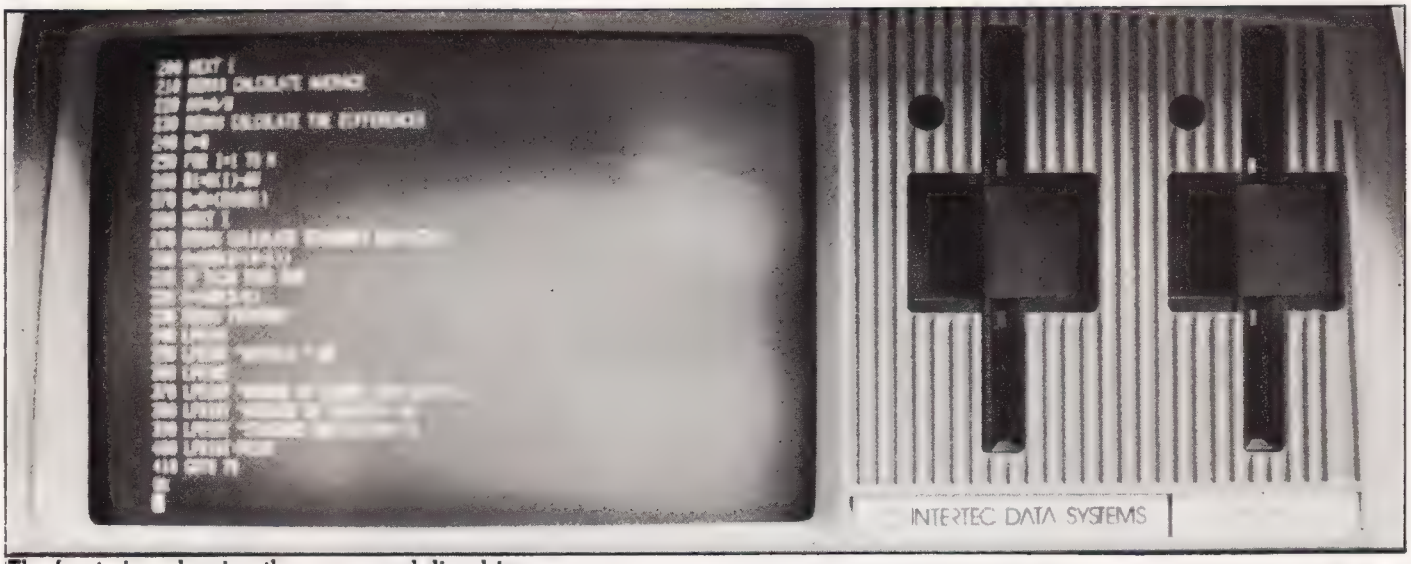
The SuperBrain reposing in its normal working environment.

Brain typifies the 'music centre' approach to electronic consumer goods. As with hi-fi, if you don't like trailing wires and separate units, there is a lot to be said for it. All you need is a desk, a SuperBrain, and a printer of your choice and you have an ideal business system. Because of this 'no fuss' approach to the electronics of computing we might expect that Intertec would offer a similar approach to the other aspect of computing — the software. The test of how easy it is to use a piece of software depends not only on how well written, but also on how well documented it is. Unfortunately, the SuperBrain fails on both counts. The standard system software is CP/M 2.2 and the best thing that can be said about that choice is that a lot of people use it and there is a lot of software available for it. CP/M is not easy to use at the best of times and Intertec have done nothing to make it any better. The manual supplied is large and impressive but it is simply a re-bound collection of the various software manuals produced by the software houses. It is not a beginner's manual. But, to be fair, there is a section that will tell you how to get started when you first receive your computer — from then on you're on your own. There is no getting away from the fact that the SuperBrain is a CP/M machine and it is CP/M which governs the way the user sees the machine. The point is, apart from the small hardware problems discussed above, any frustration that the SuperBrain generates is due to CP/M and is shared with every other machine running a standard version of CP/M. My advice to Intertec is that if they want to make the SuperBrain easier to use and hence available to a wider market, they should spend time improving their documentation and, if possible, write (or acquire, as some already exist) a better, but CP/M compatible, operating system. This would be more rewarding than any amount of hardware development. My advice to the average user is to decide if CP/M is the operating system for you, ie do you need the range of software that only CP/M can offer? If it is, then the SuperBrain runs it as well as most!

The other software that comes with the SuperBrain includes the excellent MBASIC from Microsoft. There is not much to say here except that it *is* the standard against which most BASICs are measured. Further offerings include a RAM test program — easy to use but when it finds a fault it fails to tell you where the memory error has occurred — a standard disc formatting program, a system configuration program which allows you to set the baud rate etc of the two serial ports and all the usual standard CP/M utilities, such as ED (editor), ASM (assembler), DDT (machine code debug program) and PIP (copy and data transfer program). The only standard CP/M program that has been modified by Intertec is PIP. This can now be used to send and receive data over the main serial port thus allowing the SuperBrain to be used as a slightly intelligent terminal or even as a simple VDU.

Technical Details

From a technical point of view, the SuperBrain is a fascinating machine! Most of the advertising literature shouts about its technical virtues in terms like 'Fast Dual Processors', 'twin Z80 design' etc, giving the impression that something special lurks beneath the covers. After a brief study, the technical as



The front view showing the screen and disc drives.

The connection sockets for I/O at the rear.

well as the not-so-technical user is likely to come away with the impression that 'twin Z80 design' implies that things will happen twice as fast — ***not so***! Let's clear up this confusion once and for all.

QUESTION: Does the SuperBrain's use of two Z80 processors make it faster than an equivalent machine?

ANSWER: No! The two processors are used in such a way that when one is doing something the other one is idle!

To find out why the SuperBrain is built in such a strange way we need to examine it in more detail.

Construction: The case of the SuperBrain is made from a thick, but brittle, plastic that Intertec refers to as 'Structural Foam'. It is adequate, but remember the term brittle — it will crack under impact so be careful when carrying it about. A cautionary note is clearly printed on the back of the SuperBrain warning, 'removal of cover screws will void your warranty'. This is liable to deter many owners from even a quick peep inside, so perhaps the following revelations will come as news to those of you with access to a SuperBrain as well as those without.

Inside the layout is fairly spacious and divides into three modules:

1) the main logic board carrying the keyboard, all the memory, the two Z80s, the VDU display electronics and the disc interface;
2) the twin disc drives and their analogue circuits;
3) the power supply and the CRT module.

A fan is mounted under the drives and (thankfully) it's quiet. (Or perhaps you can't hear it over the hum of the drives!) Interconnection between the various modules is by ribbon cable and connectors so the whole lot can come to pieces easily. This makes servicing easy if you can find a dealer who will swap faulty modules. One problem with mounting all the modules in one box is that logic circuits don't like either the EHT, or the high frequency noise generated by monitors, and monitors don't like the varying magnetic fields produced by the motors contained in drives. I am pleased to say that the SuperBrain suffers from none of the obvious problems. The monitor is well screened from the motors and the logic board.

The Power Supply: This is a switched mode design so there is no large power transformer. Intertec designed a 115 V unit so a stepdown transformer and an extra power switch have to be added for UK use. There is a fair amount of RF interference which comes from the SuperBrain and it's more than likely that most of it comes from the power supply. So if you're in the habit of listening to a radio while you compute — forget it!

The CRT Module And Disc Drives: There's nothing special about either the CRT module or the drives. Both are easy to remove for servicing and should give no problems.

Main Logic Board: The main logic board is really the essential SuperBrain — it's where it all happens (er . . . yeah . . . Man! Ed.). The printed circuit board itself is not very well mounted and can be flexed with very little pressure. This may not seem to be much of a problem as it's not normal to use a machine while prodding its PCB with a finger, but if it's not well mounted, vibration can be a problem for socketed chips and, in extreme cases, can crack the copper foil. The layout is quite good but on my model there are signs of modifications. Another problem might be caused by the thinness of some of the copper tracks. Thin copper tracks are fine while the unit is working but, if it goes wrong, some poor engineer has to unsolder faulty chips and replace the copper tracks which peel off with wire. You may say that this is a problem for the engineer and of no concern to the

user, but the more a PCB is cut about the less reliable it is.

The basic design of the SuperBrain can be seen in Fig. 1. The first thing that should strike you is that it's very complicated. Most of this complication comes from the use of the two Z80 processors, each complete with its own RAM. The first Z80 deals with the main memory and the CRT controller and the second interfaces directly to a 1719 disc controller. The 1719 disc controller is a very sophisticated piece of electronics — it's almost a microprocessor in itself and is quite capable of looking after a disc system on its own (as it does in countless other machines). So, why does the SuperBrain need a second Z80? The only possible reason that I can think of, apart from the obvious one that the people at Intertec found it easier to design in two halves, is that the first Z80 is involved in some critical timing operation which would interfere with normal disc operation. When a sector of a disc is being read by the 1719 a stream of bytes is produced which must be taken and stored in memory. If the processor cannot take the bytes fast enough then the 1719 cannot do anything about it and some of the data is lost. So if the first SuperBrain processor was doing something periodically that couldn't be stopped, then this might force the designers to install a second processor especially to read data from the 1719. The problem is, what is the first processor doing? An examination of the circuit diagram shows that the only device which could demand periodic servicing is the CRT controller and the SuperBrain manual confirms that the first Z80 does 'talk' to the controller 25 times per video frame. This certainly explains why the first processor is not available to handle the disc I/O. It doesn't explain why the CRT controller needs attention about every 1/500th of a second. A CRT controller is like a disc controller, almost a microprocessor in its own right, and most can display a screen full of data without any help. The more you examine the SuperBrain the more difficult it becomes to fathom the reasons behind the design!

The main 64K of memory is standard 4116 dynamic RAM refreshed by the first Z80. Not all of this can be used by programs as the top 2K is shared with the CRT controller to provide the 24 by 80 memory mapped screen. So the SuperBrain is really a 62K machine. The second processor has 1.25K of RAM all to itself along with 2K of PROM. The two processors talk to each other through three eight-bit I/O ports and the first processor can read and write the second's RAM and ROM. As the first processor has a full 64K of memory, this is done by switching out the bottom 16K of main memory and replacing it with the ROM, and switching out the third 16K when access to the disc RAM is required. The procedure that the SuperBrain has to go through to read an area of disc is something like: first swap the third 16K of RAM with the disc RAM and set up a number of parameters such as disc, side, track and sector; tell the second processor that there is something for it to do; wait until the second processor has read the sector into the disc RAM; again access the disc RAM and transfer the disc data to the place where it is needed in the memory.

The SuperBrain is really a single-board computer! The area of chips at the top left of the keyboard is the 64K of RAM.

All this must make disc access slower. Most machines use their disc controller to transfer the data directly where it is required, rather than into a special fixed location buffer first.

Another feature of the main board is the integral keyboard. A clever machine like the SuperBrain surely has some special way of coping with the keyboard? But no, we have a standard keyboard encoder chip feeding ASCII characters through an I/O port. Suddenly the reason why the SuperBrain is such a peculiar machine becomes clear — nearly all of the components are very large chips! In my opinion the SuperBrain is the product of designing a computer using nothing but LSI components even if they don't quite go together!

In conclusion of this, admittedly rather technical, look at the SuperBrain, I offer the following observations!

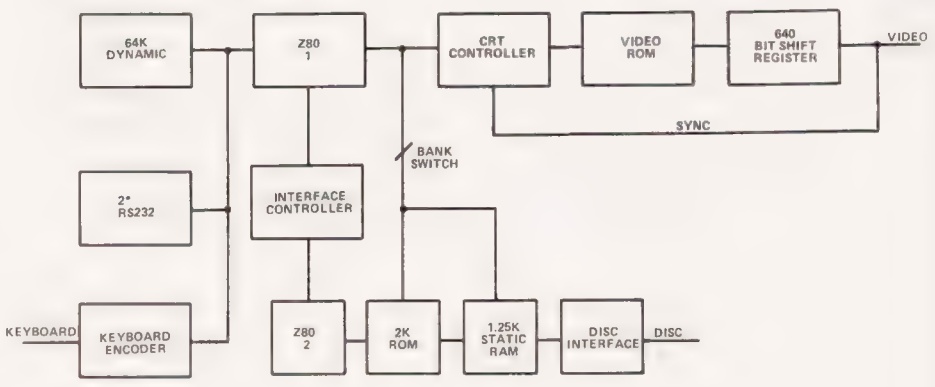


Fig. 1. This is the basic functional diagram of the hardware.

1) The SuperBrain is a very interesting machine!
2) The odd design is likely to make servicing (other than simple replacement of modules) hell; ie *I* would not like to service one!
3) Apart from the second comment the odd design is not important to a non-technical user.

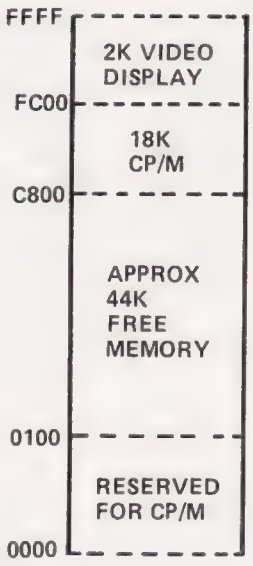
Documentation

Although I've mentioned documentation before, this review would not be complete without commenting on the lack of any real technical information. The user manual contains a number of nice photos of the interior and a brief, vague description of the workings but not much else. If you follow the offer at the end of the manual and send off for service information, all you'll get is a scroll of circuit diagrams. This is essential service information, true, but it would be nice to get a little more for your money. If you've got a special application in mind which requires detailed information on how the twin Z80 system works, then you'll have to decipher the thing for yourself. One 'plus' is that Intertec have included a listing of the BIOS part of their CP/M. This makes altering the way the peripherals are handled easier.

Expansion

I've no doubt that by now I've got a lot of SuperBrain dealers up in arms ready to defend their product by telling me how my criticisms can be overcome using this or that add-on. It is true that all sorts of goodies are available to make the SuperBrain into a better machine but these, of course, add to the cost. To get over my main criticism you can buy a chunk of electronics which will give the display true descenders (and if you've forgotten what these are, go back to the beginning of the review!). You also get some extra graphics facilities but the enhancement will add about £300 to the cost. You can also get an improved version of CP/Ms BIOS module for about £100, which adds a real-time clock, a repeat key, handshaking on the serial ports and mixed 5¼" and 8" drives.

The question of expansion usually means adding more memory, but in the SuperBrain's case it already has a full 64K. However, Intertec have made a point of advertising the fact that the SuperBrain is an S100 machine. To be precise it can use S100 cards via an adaptor. The point of this is not to add extra memory but to use S100 interface cards such as A to Ds, 8" disc controllers etc. If you look inside the SuperBrain manual you can even see a photo of the adaptor in use and very neat it looks. The trouble is that I have not been able to get hold of one, nor can I get any word from Intertec about when one might be available! It is true that an alternative is available from UK distributors for £250 but what Intertec are up to advertising S100 capability for so long without producing it, is beyond me. It's not as if it's a difficult thing to design or an expensive one to produce. What makes the non-appearance of the S100 adaptor even stranger is the availability of a 10 megabyte hard disc which connects directly to the SuperBrain's internal bus — it would have been easier to produce the S100 bus adaptor and use an S100 hard disc interface board rather than develop one from scratch. Anyway if you need a 10M SuperBrain you can have it!



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The SuperBrain has a very straightforward memory map if you ignore all the strange goings-on with the second processor. Nowhere in the documentation will you find a memory map, so I've had to deduce where everything is. If I've got it right, there is much less user memory available than you would expect. A standard CP/M should only take about 12K.

Conclusions

If you've only read the first part of this review — the user's view — then you'll think that the SuperBrain is not a bad machine. If you've read the whole review then you'll think that the SuperBrain is not such a well-designed machine. There is no contradiction here because the electronics inside a computer affect very little the way it appears to the user. What the electronics does is to determine the machine's limitations, its price and reliability. Because the SuperBrain is a fully expanded system its limitations are shared by all 64K double speed Z80 machines and, because Intertec keep the price low (presumably by high volume production), the design is acceptable. So the only area in which the electronics can affect the user is in reliability and servicing. In my opinion the SuperBrain is reasonably reliable but can be expensive to service. For example if the CRT controller chip fails, a replacement costs £30 without labour! Also, because of its complexity, servicing is not something that can be undertaken by just anyone.

The SuperBrain is still worth considering for most business or number-crunching applications but it would be even better if the lower case character format was improved and if the up-graded BIOS was standard.

Summary

CPU	Two Z80As
Clock	4MHz
User Memory	Approx 44K
I/O	2 RS232 serial 1 internal bus connector
Keyboard	QWERTY + numeric keypad + 4 cursor control keys
Discs	2 5¼" either SS DD at 350K total or DS DD at 700K total soft sectored, 512 bytes per sector
DOS	CP/M 2.2 18K
Display	12", 24 lines by 80 characters upper/lower case (no true descenders) plus a wide range of special characters
Dimensions	14⅝" x 21⅜" x 23⅛"
Weight	About 45lb
Price	Varies from about £1700 to £2000

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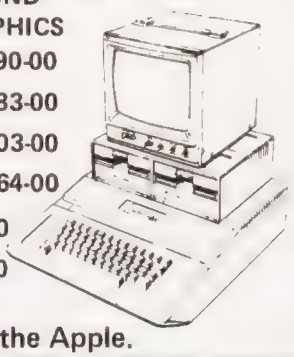

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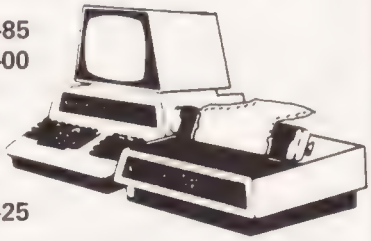

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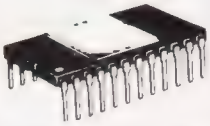

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LS40	28	LS247	135
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LS47	85	LS249	135
LS48	120	LS251	130
LS49	120	LS253	130
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LS90	60	LS295	215
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LS112	60	LS352	185
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LS122	70	LS366	85
LS123	85	LS367	85
LS124	180	LS368	85
LS125	60	LS373	180
LS126	60	LS374	180
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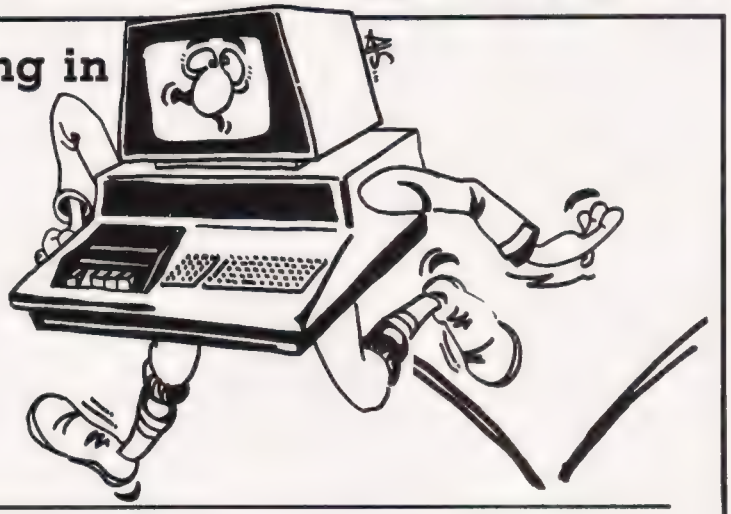
LEAPFROG

Seamus Dunn

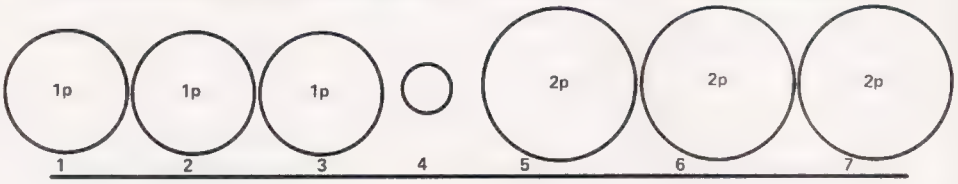
A game, it's concepts, planning in implementation for the PET



The program Leapfrog is about a relatively simple but very interesting board game which is often played in pubs with coins. In its usual form there are six coins and seven spots, as shown in Fig. 1.

The purpose of the game is to interchange the two sets of coins, and the rules are very simple:

1 The LEFT coins can move only to the RIGHT and the RIGHT coins can move only to the LEFT.
2 There are two possible types of move:
(a) to an adjoining empty spot;
(b) over another coin to an empty spot (like in checkers).



Of course, the number of spots can be any odd number so that, for example, there might be four coins on each side and a spot in the middle making nine spots altogether. The program allows you to choose between three, five, seven and nine spots.

Game Strategy

There are two distinct advantages to playing the game on a computer VDU. In the first place, the initial stages of becoming clear about just what is permitted in a game are much more easily handled on a computer. Because, while it will obviously allow you to make wrong or foolish moves, it will not allow you to make illegal or incorrect moves. This means that the machine forces you to learn the rule structure of the game very quickly and forces you further into concentrating on strategy.

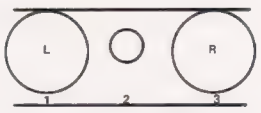
The second advantage is that it is possible for the computer to keep a record of all the moves made in any particular game. At the end of the game this record can be assessed and studied. In this way wrong moves can be detected, winning patterns become clear and the structure of the game emerges.

Like all games the initial motivation for playing is pleasure, and this should not be minimised in any way. So, at this stage all readers ought to go off, type in the game and play it for a while. But eventually pattern of movements will begin to emerge and curiosity will develop about how the game might be symbolised and its structure analysed. When that stage is reached the educational and, in this case mathematical, aspects of the game begin to become more interesting and that is the ideal outcome. That is to say, not only is there pleasure to be gained, but eventually there is an educational payoff.

Program Analysis

This next section is an attempt to analyse and generalise this particular game and the program can be used at each stage to test the results and conclusions. But remember that this is a second-level activity and ought to follow some experience at playing the game. When you have read this next part you will know how to succeed at the game and how to generalise and the interest will be purely academic.

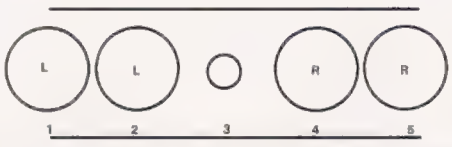
The simplest version of the game looks like this:



A few quick trials will show that the successful strategy is very simple and can be coded as: LRL (or RLR). This means:

First move the L from 1 to 2.
Then move the R from 3 to 1.
Then move the L from 2 to 3.

The next version of the game looks like this:



In this case the successful strategy (if you start by moving 2 is coded as: L RR LL RR L. This means:

First move an L piece.
Then move two R pieces.
Then move two L pieces.
Then move two R pieces.
Finally move an L piece.

Notice that the number pattern is 1 2 2 2 1. The strategies for versions of the game with three, five and seven spots are as follows:

LRL
L RR LL RR L
L RR LLL RRR LLL RR L

Turn these into number patterns as before:

1 1 1
1 2 2 2 1
1 2 3 3 3 2 1

and the nine spot version becomes, one would guess,

1 2 3 4 4 4 3 2 1

This means, begin by moving one L piece, then two R pieces, then three L pieces, and so on. You can try this out on the nine spot version on the computer and it does work.

At this stage the pattern is so simple and obvious that it is quite easy to succeed at any version of the game. But its analysis is not quite complete. The general case can be symbolised as the case with 2 N + 1 spots. That is, N spots on the left, N spots on the right, and one spot in the middle. So the pattern of movements can be shown as:

1 2 3 . . . N N N . . . 3 2 1

That is, one LEFT move, two RIGHT

moves, three LEFT moves and this continues until N moves are necessary. This number of moves, ie N, occurs three times, and then the number begins to reduce by one each time until one move only is necessary. At this stage the game is over.

The final question may well be, what is the total number of moves necessary at each level of the game, and this generalised pattern can be used to answer this. In the general case, the total number of moves is:

$$(1+2+3+\ldots+N)+N+(N+\ldots+3+2+1)$$

That is, $2(N)+N=N(N+2)$.

A$,B$,P1,Z$	Temporary variables
SP1,SP(N)	Screen positions
C,C1,C2	Counters
A(N)	Record of where spot is, ie Left, Right or Middle
B(N)	Record of end status of points for checking
S	Character number for screen display
P1	Temporary variable for SP(N)
Z	Number of spots in game
ZL,ZM,ZR	Left, Middle and Right specific values of Z
CS,NS	Current spot and New spot. That is, numbers of spot's last and new positions
R$	Record of moves made.

Table 1. The various variables.

5- 30	Introduction
35-330	Sets up example on screen, describes game and its rules
350-480	Chooses game and sets up appropriate screen display
500-555	Spot to be moved and where to, and checks legality of move
600-640	Moves Left to Right
650-690	Moves Right to Left
700-710	Spot is empty message
750-760	Spots too far apart message
800-810	Spot is not empty message
820-830	Wrong direction message
840-915	Checks for solution.
1000	Makes spots on screen
1100	Numbers spots on screen
2000	Removes a large message from top of screen
3000	Removes a small message from top of screen
4000	Removes a message from bottom of screen
5000	Holds screen until key is pressed.

Table 2. Program sections and subroutines.

Program Listing

```
  5  A$="[REV]---LEAPFROG---[OFF]":R$=""
 10  PRINT "[CLS]";TAB((40-LEN(A$))/2) A$
 15  INPUT "[CD][5 CR][REV]DO YOU WANT
     INSTRUCTIONS.[OFF][2 CR]*[3 CL];B$
 20  IF LEFT$(B$,1)="Y" THEN 35
 25  IF LEFT$(B$,1)="N" THEN 350
 30  PRINT "TRY AGAIN":GOTO 10
 35  PRINT "[CD]YOU CAN HAVE 3, 5, 7 OR 9
     POINTS IN"
 40  PRINT "[CD]EACH GAME. WE WILL
     DEMONSTRATE WITH 7"
 45  PRINT "[CD]AND THEN YOU CAN CHOOSE."
 50  GOSUB 5000:PRINT "[CLS]"
 65  SP1=33052:REM**SCREEN POSITION 1
 70  REM**SET UP SEVEN POINTS
 75  FOR C=1 TO 7:SP(C)=SP1+4*(C-1):NEXT
 80  FOR C=1 TO 3:A(C)=1:B(C)=2:NEXT:REM**
     LEFT HAND POINTS
 85  A(4)=0:B(4)=0:REM**MIDDLE POINT
 90  FOR C=5 TO 7:A(C)=2:B(C)=1:NEXT:REM**
     RIGHT HAND POINTS
100  GOSUB 3000
102  PRINT "[HOM]FIRST OF ALL THERE ARE 7
     SPOTS."
105  PRINT "[CD][4 SPC][REV]LIKE
     THIS:-[OFF]"
110  S=46
115  FOR C=1 TO 7
120  P1=SP(C)
125  GOSUB 1000:REM**SETS UP 7 POINTS
130  GOSUB 1100:REM**NUMBERS POINTS
135  NEXT C
140  GOSUB 5000:GOSUB 4000:GOSUB 3000
150  PRINT "[HOM]THERE ARE 3 [REV]L[OFF]
     BLOCKS ON"
152  PRINT "[5 CR]THE LEFT,[REV]LIKE
     THIS:-[OFF]"
155  S=12
160  FOR C=1 TO 3
165  P1=SP(C)
170  GOSUB 1000
175  NEXT
180  GOSUB 5000
185  GOSUB 4000:GOSUB 3000
190  PRINT "[HOM]THERE ARE 3 [REV]R[OFF]
     BLOCKS ON"
191  PRINT "THE RIGHT....[REV]LIKE
     THIS:-[OFF]"
195  S=146
200  FOR C=5 TO 7
205  P1=SP(C)
210  GOSUB 1000
215  NEXT
220  GOSUB 5000:GOSUB 4000:GOSUB 3000
230  PRINT "[HOM]YOUR TASK IS TO MOVE THE
     [REV]L[OFF] BLOCKS TO"
232  PRINT "WHERE THE [REV]R[OFF] BLOCKS ARE
     AND VICE VERSA"
235  PRINT "SO THAT THEY END UP [REV]LIKE
     THIS:-[OFF]"
240  GOSUB 5000:GOSUB 4000
245  S=146
250  FOR C=1 TO 3
255  P1=SP(C)
260  GOSUB 1000
265  NEXT
270  S=12
275  FOR C=5 TO 7
280  P1=SP(C)
285  GOSUB 1000
290  NEXT
295  GOSUB 5000:GOSUB 4000
300  PRINT "[CLS]THERE ARE THREE RULES:-"
305  PRINT "[CD]1. LEFT BLOCKS CAN MOVE
     ONLY"
306  PRINT "[3 CR]TO THE RIGHT AND RIGHT
     BLOCKS"
310  PRINT "[3 CR]CAN MOVE ONLY TO THE LEFT"
```

```
315  PRINT "[CD]2. A BLOCK CAN BE MOVED TO AN"
316  PRINT "[3 CR]ADJOINING SPOT IF IT IS
     EMPTY"
325  PRINT "[CD]3. A BLOCK CAN JUMP OVER AN"
326  PRINT "[3 CR]ADJOINING BLOCK AS IN
     CHECKERS"
330  GOSUB 5000:GOSUB 4000
350  INPUT "[CLS]HOW MANY SPOTS DO YOU WANT
     (3,5,7,9)[2 CR]*[3 CL]";Z
355  SP1=33048:REM**SCREEN POSITION 1
360  REM**SET UP Z POINTS
365  ZL=(Z-1)/2:ZM=(Z+1)/2:ZR=(Z+3)/2
370  FOR C=1 TO Z:SP(C)=SP1+4*C-2*Z+17:
     NEXT C
375  FOR C=1 TO ZL:A(C)=1:B(C)=2:NEXT C:
     REM**LEFT HAND POINTS
377  A(ZM)=0:B(ZM)=0:REM**MIDDLE POINTS
380  FOR C=ZR TO Z:REM**RIGHT HAND POINTS
385  A(C)=2:B(C)=1
390  NEXT C
400  PRINT "[CLS]"
405  S=12
410  FOR C=1 TO ZL
415  P1=SP(C)
420  GOSUB 1000
425  GOSUB 1100
430  NEXT C
435  S=46
440  P1=SP(ZM)
445  GOSUB 1000
450  GOSUB 1100
455  S=146
460  FOR C=ZR TO Z
465  P1=SP(C)
470  GOSUB 1000
475  GOSUB 1100
480  NEXT C
500  GOSUB 3000
502  PRINT "[HOM]IF AT ANY TIME YOU WISH TO
     STOP PRESS 99"
505  GOSUB 5000:GOSUB 4000
506  GOSUB 3000
507  PRINT "[HOM]CHOOSE THE NUMBER OF THE
     [REV]BLOCK[OFF] THAT YOU"
509  INPUT "WISH TO MOVE[2 CR]*[3 CL]";CS:
     REM**CURRENT SPOT
510  IF CS=99 THEN 905:REM**END
515  IF A(CS)=0 THEN 700:REM**SPOT EMPTY
520  GOSUB 3000
522  PRINT "[HOM]CHOOSE THE NUMBER OF THE
     [REV]SPOT[OFF] TO WHICH YOU"
525  INPUT "WISH TO MOVE[2 CR]*[3 CL]";NS:
     REM**NEW SPOT
535  IF NS=99 THEN 905:REM**END
540  IF ABS(CS-NS)>2 THEN 750:REM**MORE
     THAN TWO APART
545  IF A(NS)<>0 THEN 800:REM**SPOT NOT
     EMPTY
550  IF A(CS)=2 THEN 650:REM**RIGHT TO LEFT
555  IF A(CS)=1 THEN 600:REM**LEFT TO RIGHT
600  REM**MOVE LEFT TO RIGHT
605  IF NS<=CS THEN 820:REM**WRONG WAY
607  R$=R$+"L"
610  S=46:P1=SP(CS)
615  GOSUB 1000
620  S=12:P1=SP(NS)
625  GOSUB 1000
630  A(CS)=0:A(NS)=1
635  PRINT "[REV]NOW NEXT MOVE[OFF]"
636  GOSUB 3000
640  GOTO 840:REM**CHECKS IF COMPLETE
650  REM**MOVES RIGHT TO LEFT
655  IF NS>=CS THEN 820:REM**WRONG WAY
657  R$=R$+"R"
660  S=46:P1=SP(CS)
665  GOSUB 1000
670  S=146:P1=SP(NS)
675  GOSUB 1000
680  A(CS)=0:A(NS)=2
685  PRINT "[REV]NOW NEXT MOVE[OFF]"
686  GOSUB 3000
690  GOTO 840:REM**CHECKS IF COMPLETE
700  REM**SPOT EMPTY
705  PRINT "[REV]THERE IS NO BLOCK ON THIS
     SPOT[OFF]"
710  GOSUB 5000:GOSUB 4000:GOSUB 2000:
     GOTO 507
750  REM**MORE THAN 2 SPOTS APART
755  PRINT "[REV]THE SPOTS ARE TOO FAR
     APART[OFF]"
760  GOSUB 5000:GOSUB 4000:GOSUB 2000:
     GOTO 507
800  REM**SPOT NOT EMPTY
805  PRINT "[REV]THIS SPOT IS NOT EMPTY. TRY
     AGAIN[OFF]"
810  GOSUB 5000:GOSUB 4000:GOSUB 2000:
     GOTO 507
820  REM**WRONG DIRECTION
825  PRINT "[REV]YOU CANNOT MOVE IN THAT
     DIRECTION, TRY AGAIN[OFF]"
830  GOSUB 5000:GOSUB 4000:GOSUB 2000:
     GOTO 507
840  REM**CHECK IF COMPLETE
842  GOSUB 2000
845  FOR C=1 TO Z
850  IF A(C)<>B(C) THEN 860
855  GOTO 865
860  C=7:GOTO 506:REM**NOT COMPLETE
865  NEXT C
870  REM**COMPLETED
875  GOSUB 3000
880  PRINT "[14 CD]CONGRATULATIONS"
885  PRINT "YOU HAVE SUCCEEDED"
887  INPUT "[CD]DO YOU WISH TO SEE YOUR
     SOLUTION[2 CR]*[3 CL]";Z$
888  IF LEFT$(Z$,1)="Y" THEN 895
890  IF LEFT$(Z$,1)="N" THEN 915
891  GOTO 887
895  PRINT "[15 CR][5 CD]";R$
900  GOTO 915
905  INPUT "[17 CD]DO YOU WISH TO SEE YOUR
     SOLUTION[2 CR]*[3 CL]";Z$
906  IF LEFT$(Z$,1)="Y" THEN 910
908  IF LEFT$(Z$,1)="N" THEN 915
910  PRINT "[15 CR][5 CD]";R$
915  END
1000 REM**MAKES SPOTS
1010 FOR C1=0 TO 200 STEP 40
1020 FOR C2=P1 TO P1+1
1030 POKE C1+C2,S
1040 NEXT C2
1050 NEXT C1
1060 RETURN
1100 REM**NUMBERS POINTS
1105 POKE C1+C2+78,C+48
1110 RETURN
2000 REM**CLEARS TOP OF SCREEN, LARGE
2005 FOR C=32768 TO 33007:POKE C,32:NEXT C:
     RETURN
3000 REM**CLEARS TOP OF SCREEN, SMALL
3005 FOR C=32768 TO 32927:POKE C,32:NEXT C:
     RETURN
4000 REM**CLEARS BOTTOM OF SCREEN
4005 FOR C=33688 TO 33708:POKE C,32:NEXT C:
     RETURN
5000 REM**HOLDS SCREEN
5002 PRINT "[HOM][23 CD][5 CR][REV]PRESS ANY
     KEY[OFF]"
5005 GET Z$:IF Z$="" THEN 5005
5010 RETURN
```

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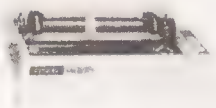

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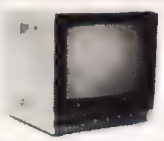

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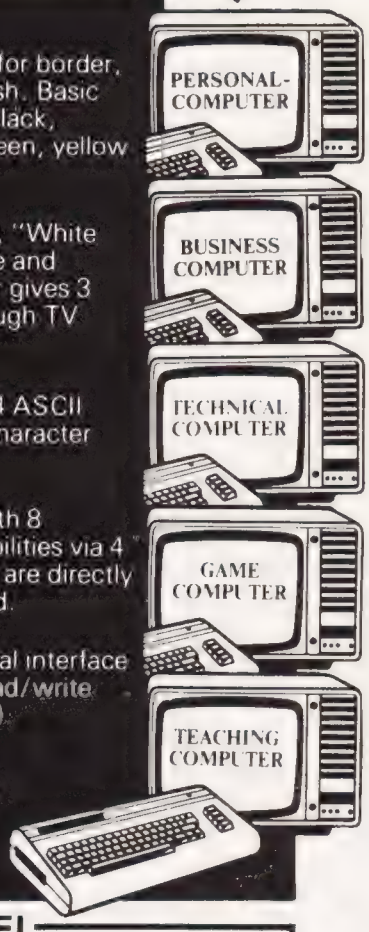

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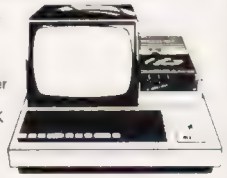

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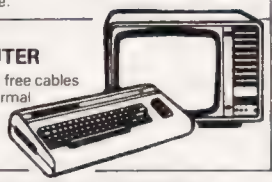

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PC1211 PROGRAMMING

As manufacturers make computers smaller their facilities tend to get compressed. We show you how, despite their size, to get the most out of the new generation of handheld computers.

Technology has moved so fast in the last decade that it is now quite common for manufacturers to 'undersell' their products. Often the machines they produce are capable of operating in much more sophisticated ways than anyone would suspect from the accompanying literature.

Whatever the reason may be for this attitude, the manufacturer's literature on the Sharp PC1211 doesn't give more than a tiny fraction of the possible ways of using it. The PC1211 is a remarkable machine, in that it is completely portable (three batteries costing about £1.45 each being the power supply). It enables the user to carry his computer with him wherever he goes — even into the bathroom, where any other machine might be lethal — churning away in his pocket and beeping audibly when it has finished whatever it was programmed to do. The unit costs under £100 and it performs entirely to specification. In this article we shall explore the ways in which the PC1211 can be persuaded to perform ***beyond*** its specification.

First A Warning

Having had the use of a PC1211 for a fortnight, I decided that it would only be fair to let someone else have a go. I passed the machine to a colleague who was considering whether to buy a PC1211 — or something similar — for himself. On the Monday morning I expected him to declare his enthusiasm, or at the very least to have forgotten to bring it in with him. On the contrary, I found a curt note on my desk saying that he had had nothing but trouble with the PC1211, which had failed to execute even the simplest program without apparently going into a infinite loop.

What had gone wrong? Basically, he had not read the manual before trying to write a program. No one could blame him, because the documentation is written in that quaint cross between Japanese and English that seems to accompany so much domestic electronic equipment these days. With phrases like 'By all means switch the machine off' (before connecting or disconnecting the cassette interface) which actually means 'For goodness' sake switch off' because you might blow it up. The manual is not really ideal for the first-time computer-buyer at whom the machine should be aimed.

The first program my friend wrote was roughly like this:

```
10  FOR I=1 TO 10
20  A(I)=1
30  NEXT I
```

This program will cause the PC1211 to go to sleep! If you try it, use BREAK to escape, because otherwise you will just run the batteries down. The AUTO SWITCH-OFF doesn't operate if the computer is churning away uselessly in an infinite loop, as it does in this case.

The reason for this is that the memory A(9) is the same as the memory I, so that I is reset to 1 whenever it gets as far as 9 and thus never reaches 10. The same sort of error will arise for any dummy subscript which resets itself accidentally.

So, for example

```
10  FOR B=1 TO 10
20  A(B)=5
30  NEXT B
```

will skip A(3), A(4) and A(5), and it will leave A(2) as 10.

Some Space-saving Tricks

The main problem with the PC1211 is that you are limited to 204 memories or, allowing for the 26 memories A-Z which are always available (fixed memories), you have the ability to use the remaining 178 memories either to store data or to store up to 1424 steps of BASIC program. A simple calculation shows that 8 steps of program take up the same amount of space as one memory.

Let us look at ways of saving space by writing our programs economically. Luckily there are a few tricks that even Sharp don't seem to have stumbled on, and it is possible to save a large number of bytes by writing compact code.

Each BASIC code-word, like INPUT or GOSUB, etc., takes just one byte (the MEM instruction shows how this happens). Each BASIC line has an overhead of three bytes for the line-number, so that it is cheaper to pack statements together: this costs the one byte for a colon needed to separate the statements. But watch out! It is, of course, impossible to put anything after an IF THEN statement on the same line.

Each character in a string is stored as one byte. So, if you write

```
10  INPUT "INPUT THE VALUE OF R";R
```

you are using 19 bytes more than if you had been satisfied with

```
10  INPUT "R=";R
```

One neat abbreviation is provided by the fact that as a result of being allowed only single-character variables in BASIC (A or A(1) but not A1 or AB) the machine understands AB as meaning 'the product of A and B'. But, it is not ***just*** the same as A*B: AB has priority over both multiplication and division.

AB is processed before A*B and before A/B but not before A^B. You can always save one byte by writing

A*B as AB, and often (but not always) you can save three bytes by replacing (A*B) by AB. This may not seem much, but remember that every time you save eight bytes (steps) you have liberated another 32-bit memory for data storage.

The expression 2A is also understood, instead of 2*A, but only in RUN mode, not in PROGRAM mode (where 2 would be taken as the line number). A2 gives Error Number 1.

Thus if A = 2, B = 1 and C = 10

```
10  PRINT A/BC GIVES 0.2 IN 8 STEPS
10  PRINT A/(B*C)    0.2   11
10  PRINT AC/B      20.0    8
10  PRINT A/B*C     20.0    9
```

But...

```
10  PRINT ABC^2   200.0
```

The IF Statement

If you sit down at your microcomputer and enter (A>C), what happens? If, as with the PC1211, you get either a 1 for a 0 according to whether the number A is in fact bigger than the number in memory C or not, then you can use your micro in all sorts of neat (and exciting) ways that can make light of what might be quite intricate programming problems. (To save you doing it with your Apple, you will be pleased to know that it will work exactly as on the PC1211: if you are a Sinclair owner, you get -1 instead of +1 when the condition is satisfied, so everything that follows in this article applies to your machine, but upside-down, as it were).

On large computers the architects went to some trouble to distinguish between the different kinds of variables: real variables (ordinary numbers), string variables and logical or 'Boolean' variables. It was usually made very difficult to convert from one type of variable to the other (you can, for example, go from string to real in most BASICs by using VAL, and vice versa by using CHR$ — alas, not on the PC1211). The designers of the BASICs for machines like the Apple and the PC1211 either did not bother to distinguish between logical and real variables or they realised that there was no need to distinguish between them. Once the distinctions- and hence the barriers — between real and Boolean variables have been abolished, you can perform calculations with truth values like (A>C) just as if they were real numbers — you can add them, multiply by them, or even raise numbers to the power of them.

You can obtain the truth value of any statement that could go between IF and GOTO : (A=B), A-2C > = 7DD, etc. etc. You will have to put A=B inside brackets, of course, as otherwise the machine will think you are telling it to LET A=B and behave accordingly.

For the purpose of the IF statement, if the truth value of the expression to be tested is greater than 0, it is taken as true: if it is less than or equal to 0 it is taken as false.

If x is an expression. 1-x will have truth value 0 if the value of x is 1, and vice versa. This means that IF 1-x THEN 15 will be interpreted as IF NOT x THEN 15.

The statement IF NOT is not, however, accepted by the PC1211, so that this represents an extra BASIC instruction.

The following instructions are equivalent:

```
10  IF A>0.0 THEN 25     13 STEPS
10  IF A>0 THEN 25       11 STEPS
10  IF A THEN 25          9 STEPS
```

The value of (A=B)*(C=D) is 1 if both A=B ***and*** C=D, and zero otherwise. This means that * can be used to mean AND in between logical expressions.

Likewise (A=B)+(C=D) will give a positive number if either of (A=B) or (C=D) is true. This means that + can be used to mean OR between logical expressions.

If a,b,c,d,...k are logical expressions then:

IF a*b*c*d..*k will be understood as IF ALL ..... ARE TRUE

IF a+b+c+d+...+k will be understood as IF ANY OF.....ARE TRUE

IF a+.....+k =3 will be understood as IF EXACTLY 3 OF .... ARE TRUE

IF a+.....+k =3 will be understood as IF AT LEAST 3 OF .... ARE TRUE

It makes life simple to be able to use these operators when you are writing a program to perform complicated sorting operations.

The mixing of Boolean and real numbers permits you to define (in a single BASIC statement) discontinuous functions without using IF...THEN. The following are some examples:

The function

```
10  Y=(X>0)
```

defines the "step" function (Fig. 1)

The statement

```
10  Y=(X>-1)*(X<1)
```

defines the unit function shown in Fig. 2

The statement

```
10  Y=(X>0)*(X<L/2)*2HX/L+2H*
    (1-X/L)*(X<1)*(X>L/2)
```

defines the triangular wave-form of Fig. 3

Random Number Generation

The Random Number Generator in the Applications booklet is cumbersome and does not exploit the capabilities of the PC1211.

The instructions

```
(1)   R=1000*LOG(137/R)-
      INT(1000*LOG(137/R))

(2)   R=1000*LOG(137/R):R=R-INT(R)
```

can be stored as a single-line RESERVE program, eg as SHIFT A. Thus SHIFT A will display a random number (actually a pseudo-random number) R between 0 and 1, 'seeded' with the current contents of R.

R must be greater than 0 to start (actually it is best to seed it with a fairly large positive number — the day of the month or hour of the day are suitable).

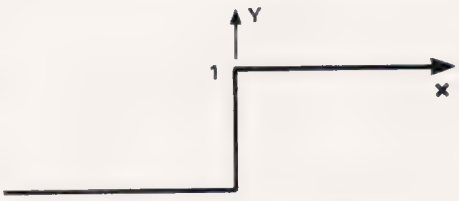

Fig. 1. The step function in graphical form.

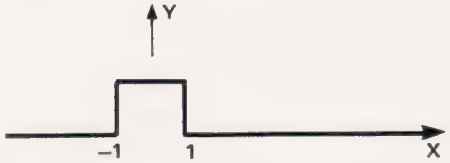

Fig. 2. A step up and a step down gives the unit function.

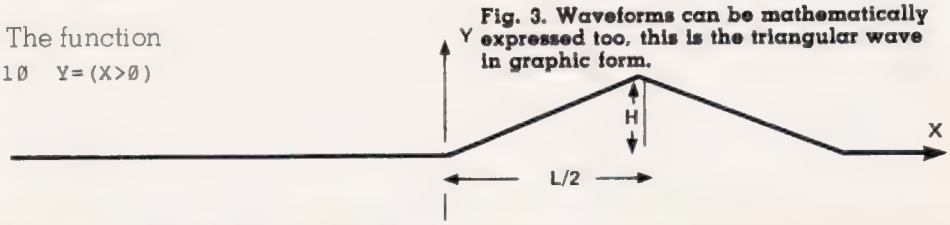

Fig. 3. Waveforms can be mathematically expressed too, this is the triangular wave in graphic form.

The sequence (ii) returns numbers truncated to a maximum of six places of decimals, while (i) returns the numbers intact. The two sequences diverge noticeably after about four steps.

A fairly complicated program that uses the random-number generator is given below. Most of the uses of random-number generators are connected with games of one kind or another: this particular game is designed to show how you can use the RNG we have designed, and also how you can write quite complicated logical expressions (like line 50) without using up several lines of code.

Line 50 means IF ANY ONE OF E F G and H IS EQUAL TO 800.... line 55 means IF NOT MORE THAN TWO OF E...H ARE EQUAL TO ZERO..... neither of which would be easy to write succinctly using the ordinary BASIC we have been used to.

One significant point (and this is mentioned but not explained in the manual) is that you can speed up your program, especially if it has long loops, by using the 'dummy' variables W,X,Y,Z rather than AB,C,....,V. The reason for this is that the incredibly compact design of the PC1211 requires that every bit (and I mean bit) of available memory is made available to the user. Inside the PC1211 are three 4K-bit RAMs, at the top of which are the reserve program memories, with stacks for the subroutines and the FOR...NEXT pointers at the bottom. Just above these stacks are the memories W,X,Y and Z. The other 22 fixed memories are in the second and third display chips. It will obviously take longer for the information to be fetched from the display chip than from the adjacent memory locations, so that the use of W,..,Z as dummies in FOR...NEXT loops actually saves about 35% of the time taken for the loop (compared with using A,..,V).

The program DICE allows you to gamble with $200 against three other players, who also have $200. As it stands, the odds are equal for all the players, but it would not take much ingenuity to fix the odds at line 160 so that the chances of winning were proportional to your stake — or just fixed in favour of one of the players. The subroutine at 270 is, in fact, not strictly written as a subroutine as we want to RETURN to line 140 wherever we called it from. The routine starting at 205 gives a random playing order, which is slightly different from the usual strict rotation and gives the game extra interest. This trick can be used in many other situations to increase the element of chance in a game: it would certainly make games of Donkey with my children fairer!

```
 10  PAUSE "DICE"
 15  CLEAR
 20  INPUT "ENTER A NUMBER >0";R
 25  E=200:F=200:G=200:H=200
 30  INPUT "NAME OF PLAYER #1?";A$
 35  INPUT "NAME OF PLAYER #2?";B$
 40  INPUT "NAME OF PLAYER #3?";C$
 45  INPUT "NAME OF PLAYER #4?";D$
 50  IF (E=800)+(F=800)+(G=800)+
     (H=800) =1 GOTO 60
 55  IF (E=0) + (F=0) + (G=0)
      + (H=0) <3
     GOTO 65
 60  PAUSE "GAME OVER":STOP
 65  GOSUB 205
 70  T=0
 75  FOR W=1 TO 4
 80  S=A(12+Q)
 85  U=4+S:V=8+S
 90  A(V)=0
 95  IF A(U)<=0 GOTO 140
100  PAUSE "YOU HAVE $";A(U)
     ;",";A$(S)
105  IF A(U)<T GOTO 290
110  INPUT "HOW MUCH DO YOU BET?
     ",A(V)
115  IF A(V)<=0 GOTO 140
120  IF A(V)>A(U) GOTO 280
125  IF A(V)<T GOTO 270
130  T=A(V)
135  A(U)=A(U)-A(V)
140  NEXT W
145  R=1000*LOG(137/R)-INT
     (1000*LOG(137/R))
150  Q=INT(4R+1)
155  IF A(8+Q)<0 GOTO 145
160  PAUSE "WINNER IS ";A$(Q)
165  FOR W=1 TO 4
170  A(4+Q)=A(4+Q)+A(8+W)
175  NEXT W
180  FOR W=1 TO 4:S=4+W
185  PAUSE A$(W);" HAS $";A(S)
190  NEXT W
195  GOTO 50
200  STOP
205  R=1000*LOG(137/R)
     -INT(1000*LOG(137/R))
210  Q=INT(4R+1)
215  M=Q
220  R=1000*LOG(137/R)
     -INT(1000*LOG(137/R))
225  Q=INT(4R+1)
230  IF M=Q GOTO 220
235  N=Q
240  R=1000*LOG(137/R)
     -INT(1000*LOG(137/R))
245  Q=INT(4R+1)
250  IF (M=Q) + (N=Q) GOTO 240
255  O=Q
260  P=10-M-N-O
265  RETURN
270  PAUSE "MINIMUM BET IS $";T
275  GOTO 100
280  PAUSE "YOUR MAXIMUM IS $";A(U)
285  GOTO 110
290  PAUSE "THE MINIMUM IS $";T
295  PAUSE "SO YOU MISS THIS ROUND"
300  GOTO 140
```

The variables used in the above game.

```
A$(1-4)       Player's names
also in A$-D$
A(5-8)        Player's assets
also in E-H
A(9-12)       Player's wagers
also in I-L
A(13-16)      Random order of play
also in M-P
A(17,18,23)   General purpose
also in Q, S & W
A(18)         Random number
also in R
A(20)         Max/Min bet
also in T
A(21)         4+S
also in U
A(22)         8+S
also in V
```

The program for the gambling game.

Input And Output

The INPUT statement allows a calculation to be performed. Thus

```
A=1
B=5
  10  INPUT N
```

will accept an input of, say, AB-2B and N will then contain -5.

One problem in using the PC1211 is that it is difficult to display information in compact form from within a loop. Each time a PRINT or PAUSE statement is executed, the line is terminated and the next output requires the erasure of the existing line. Moreover, it is not easy to use calculated subscripts: PRINT A(I+1) won't work for more than one variable per PRINT or PAUSE statement.

A useful device is shown in this routine:

```
500  FOR I=15 TO 38 STEP 4
501  USING"##.###"
502  G=I+1:H=I+2:J=I+3
503  PRINT A(I);A(G);A(H);A(J)
504  NEXT I
```

This routine prints output in batches of four numbers, using 24 characters. Note, of course, that we must not alter I or A(9) within the loop. The numbers to be printed must lie between -10 and +10, though this can easily be modified by changing the USING statement.

Packing It In

If you type in 2**33, the PC1211 will display the exact answer. Try 2**34 and you will notice that the PC1211 rounds the answer and puts it into scientific notation. In effect, this means that the PC1211 has a 33-bit mantissa (the decimal part of the numbers, ignoring the E part) and that you can easily store up to 33 items of information in each memory. If you wanted to you could use the exponent part of the memory, but this would require a little more ingenuity. All this assumes, of course, that you don't need anything like the accuracy of about 1 part in 10^{10} that the PC1211 gives you. In practice, you would need this kind of accuracy for scientific calculations, but not for game-playing or stock-control

applications, where most problems involve the manipulation of integers rather than real numbers.

For example, if you are writing a card-playing game, you will need to know whether or not a particular card has been dealt. If you have 32K of RAM available you might as well store each piece of information in a separate memory, setting up a 4by 13 array for the 13 values of each of four suits, and storing a 0 in each memory until the card is dealt when the 0 is replaced by a 1. The owner of the PC1211 faced with the prospect of sacrificing 52 of his precious 204 memories might well give up at this point and regard the situation as hopeless.

However, it is possible to pack these 52 items of information into two memories, as the following subroutine shows:

```
900  R=1000*LOG(137/R)-INT
     (1000*LOG(137/R))
901  E=INT(52*R)
902  GOSUB 910
903  IF F THEN 900
904  S=(E<26)*2^E+S
905  T=(E>25)*2^(E-26)+T
906  RETURN
```

The subroutine at 900 requires a seed other than 0 for R, so that R must, as mentioned previously, be initialised to a positive number. It then generates a number A between 0 and 51. The subroutine at 910 returns C = 1 if the number has been used before and C = 0 if it has not. Then if C = 0 the number A is accepted and a 1 is packed into the location corresponding to A in S if A is between 0 and 25 and in T at the location corresponding to A-26 if A lies between 26 and 51 (all ranges inclusive). If C = 1, the number A is rejected and another one generated from 900.

A suitable subroutine for unpacking binary numbers from decimal ones is as follows:

```
910  F=(E<26)*S+(E>25)*T
911  G=E-(E>25)*26
912  G=F*2^-(G+1)
913  F=INT(2*(G-INT(G))
914  RETURN
```

Similar routines can be used for packing and unpacking several integers into and out of real memories, provided only that we know the size of the largest integer we shall have to handle (here, of course, it is 1). In the extreme case shown here, where we can pack up to 32 numbers into one memory, it would be quite simple to store, say, the presence or absence of up to 5000 items and still leave space for a reasonable program. The method is particularly useful for storing compactly vast amounts of trivial information on cassette tape — eg students' marks (0-99), of which one could store 800 in a form in which one could load them simultaneously into RAM.

To make the card-dealing program complete, all one needs to do is convert the number A into a card (divide by 13 and take the integer part to find the suit, the remainder being the denomination of the card). The snag (and there has to be one, of course) is that packing and unpacking takes time — about 5 seconds per card dealt. But at least we have shown that it can be done!

In fact you would probably not be wise to let the program run right through to 52: clearly the chances are that it would take 52 times as long to find the last card as it did the first, so you might well have to wait up to four minutes for each of the last few cards. Clearly, this method is useful for games like blackjack/pontoon, where only a few cards are dealt before shuffling the pack. Shuffling the pack is achieved by setting the variables S and T to zero, so that all cards are again treated as available.

There are many other ways of dealing 52 cards in a random order, but most of them will require much more than two memories for storing the information needed. You could, for example, generate 52 random numbers and use a sorting routine like the one below, to deal the cards in descending order of the random numbers associated with them.

A suitable control routine might be something like this:

```
800  INPUT "SEED ";R
805  A$="C":B$="D":C$="H":D$="S"
810  FOR W=1 TO 52
815  GOSUB 900
820  F=INT(E/13)
825  E=E-13F+1
830  PAUSE A$(F+1);E
835  NEXT W
840  RETURN
```

Note one or two space-saving tricks. We have used the memories A-D for the strings 'C', 'D', 'H', 'S', so that we can refer to them simply as A$(F + 1), where F is 0, 1, 2 or 3, according to the suit represented by the card (random number 0-51) dealt. The memory F can be used for the suit value even though it was used to determine whether the card had been dealt before, as this is reset each time we re-enter the subroutine 910. Likewise the memory E is no longer needed after the suit has been determined at line 820. Instead of the random number 0-51 can now be used for the card value 1-13, generated by line 825. It is not difficult to modify the program to print the string J when E is 11, Q when E is 12 and K when E is 13, with A when E = 1.

A Few Ideas

Using some of the techniques I have already described, we can write efficient versions of popular routines. Here, for example, is a Bubblesort routine, for sorting numbers in memories 5 to 100 into ascending order.

```
  5  CLEAR
 10  FOR A=5 TO 100
 20  INPUT A(A):IF A=999 THEN 40
 30  NEXT A
 40  C=0
 50  FOR B=5 TO A-2
 60  D=A(B)>A(B+1)
 70  C=C+D
 80  IF 1-D THEN 100
 (OR 80  GOTO 100-10D)
 90  D=A(B):A(B)=A(B+1):A(B+1)=D
100  NEXT B
110  IF C THEN 40
120  FOR B=5 TO A-1
130  PAUSE A(B)
140  NEXT B
150  STOP
```

The INPUT routine occupies lines 5 to 30, the Bubblesort routine starts at line 40 and ends at line 110, and the OUTPUT routine runs from line 120 to line 150. At line 60 the variable D is set to 1 if A(B) is greater than A(B + 1) and zero otherwise. At line 80, if D is zero (the numbers are in correct order) the program jumps to line 100, avoiding line 90, where otherwise the numbers would be swapped over and placed in the right order. The accumulator C is set to zero before scanning the array A from 5 to A-2 to see if the numbers are in ascending order: each time a pair is found that needs to be swapped, the number D is 1, and so C will be greater than zero if any swaps are needed, and equal to zero if none were needed. When C is found to be zero, the scanning process is terminated by line 110. The program is a good example of the neat code that results from the use of the Boolean variables as if they were real numbers (as in the case of the variable D in this program).

Note, however, that we have not used the extra speed we could have had from choosing W, X, Y or Z as our loop dummy rather than B. The code would have been less easy to read, as we should have had to avoid the variable W, say, either by jumping round it whenever we reached A(22), or by starting the loop at A(23) which would look rather silly.

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How the ZX81 compares with other personal computers

SYSTEM IDENTIFICATION		ZX81	ZX80	ACORN ATOM	APPLE II PLUS	PET 2001	TRS 80 LEVEL I	TRS 80 LEVEL II
ROM		8K	4K	8K	8K	14K	4K	12K
GUIDE PRICE	Basic unit – inc. VAT	£70	£100	£175	£630	£435	£290	£375
	Unit plus 16K RAM (*12K RAM)	£120	£150	£285*	£630	£530	£360	£375
COMMANDS	LIST, LOAD, NEW, RUN, SAVE	●	●	●	●	●	●	●
STATEMENTS	PRINT, INPUT, LET, GOTO, GOSUB/RETURN, FOR/NEXT IF/THEN	●	●	●	●	●	●	●
	STEP	●		●	●	●	●	●
	TAB	●			●	●	●	●
ARITHMETIC	ABS, RND	●	●	●	●	●	●	●
FUNCTIONS	INT	●			●	●	●	●
	ATN, COS, EXP, LOG, SGN, SIN, SQR, TAN	●			●	●		●
	ARCSIN, ARCOS	●						
STRING	CHR$	●	●		●	●		●
FUNCTIONS	LEN	●		●	●	●		●
	ASC(CODE), STR$, VAL, INKEY$	●				●		●
NUMBERS	FLOATING PT $\pm 10^{-38}$	●			●	●	●	●
	INTEGERS		●	●	●	●		●
NUMERIC	A-Z			●			●	
VARIABLES	AA-ZØ				●	●		●
	An-Zn, n = any alphanumeric string	●	●					
STRING	A$ & B$						●	
VARIABLES	A$ to Z$	●	●	●				
	An$ to Zn$ n = any alphanumeric character				●	●		●
NUMERIC	SINGLE DIMENSIONAL		●	●			●	
ARRAYS	MULTI DIMENSIONAL	●			●	●		●
DISPLAY	ROWS	24	24	16	24	25	16	16
	COLUMNS	32	32	32	40	40	64	64
	LOW RES GRAPHICS (<7000 pixels)	●	●	●	●	●	●	●
	HI RES GRAPHICS (>40000 pixels)			●	●			
SPECIAL	USR (CALL, LINK)	●	●	●	●	●		●
FEATURES	PEEK, POKE (OR EQUIV)	●	●	●	●	●		●

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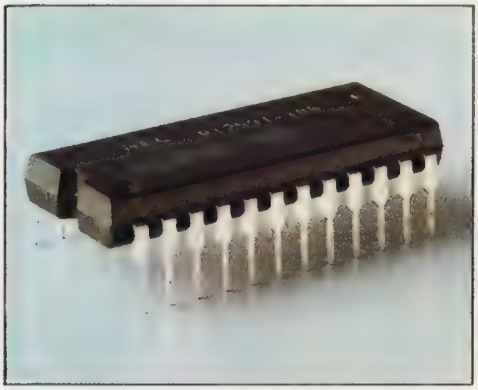

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GOING FORTH

We start a major new series on how to program in this unique language which actually grows with your use of it. Your programs will run faster than they do under BASIC but it's not difficult to use.

The Great Language Debate over the last couple of years has tended to focus on the relative advantages and disadvantages of BASIC and Pascal. Although the subject is fascinating, it becomes rather academic when, like me, you only have a 16K computer and no discs.

If you are in this position, there is no point in getting worked up over Pascal because you simply can't run any sensible version of it on your micro. Your choice is normally between BASIC, which is easy and interactive but s-l-o-w, and assembly language, which is difficult, not interactive, but very fast.

Recently, though, another possibility has had some publicity — FORTH. It is a very unusual language, originally developed in the USA for such things as the control of astronomical equipment. It is easy to write (not as easy as BASIC, but still easy), interactive and very, very fast. What's more, the compiler, operating system and fairly large programs can all fit together into a 16K cassette-based system.

This is the first of four articles which will introduce FORTH. In this part, we'll see just what FORTH is (and isn't) and examine some of its simpler characteristics.

I should mention at this point that all my specific comments, and the programming examples, are based on the FORTH system which I use. This is a particularly attractive version called MMSFORTH which runs in a 16K TRS-80 or Video Genie. It is available from Miller Microcomputer Services, 61 Lake Shore Road, Natick, MA 01760, USA.

The easiest way to pay is with a Barclaycard (the Americans call them VISA cards) or Access Card (Mastercharge) — simply quote the card number and its expiry date. That's what I did, and I received my system 17 days (including Christmas!) after I posted my letter. How's that for service? I should point out that I have no connection with MMS beyond being a satisfied customer, and that other FORTH systems are available in the UK.

First of all though — why yet another language?

Why FORTH?

The power of FORTH comes from its unusual philosophy, which allows you to add new functions (called 'words') to the language in order to match it to whatever you want to do. In other words, it is a language that lets you define your own language. Read that again slowly!

FORTH programmers create words to do whatever jobs they need, but once a word is in the language's dictionary, it can be used in any other program, and has the same status as all other FORTH words. In fact, FORTH has no way of distinguishing between the words that came with the original package and those which have been added to it.

An example might be useful here. Suppose you need to take a number and print it ***if, and only if,*** it is divisible by 3. Easy; type:

```
: 3PRINT  DUP 3 MOD Ø = IF .
ELSE DROP THEN ;
```

Then, to test a number, you simply type:

```
<number> 3PRINT <ENTER>
```

and the program prints the number if it is divisible by 3. At this point don't get to worried about what the word actually does — all should soon become clear.

3PRINT looks rather like a subroutine, but it is not — it is a totally new FORTH function. Having defined it, you can then use 3PRINT to define other FORTH words, and so on, ***ad*** (nearly) ***infinitum.*** Not only that, but you can use 3PRINT both in a program, and in an immediate mode.

The Pros...

It is this unbelievably flexible approach that gives FORTH its power, and makes it particularly useful as a (I hate the word) hobbyist language. Let's take a closer look at some of its advantages.

Speed. FORTH programs run something like 10-20 times faster than equivalent BASIC programs. For reference, Table 1 shows the results I obtained when I ran the standard 'Kilobaud' benchmarks on my Video Genie. The Table shows the times for floating point and integer BASIC, and for equivalent FORTH programs; as you can see, the increase in speed is dramatic. I could not use a floating-point arithmetic benchmark because my version of FORTH is integer-only (but it does handle them in the range ±2,147,483,648).

Interactive. Although FORTH definitions, like the one for 3PRINT above, are actually compiled into the language when you enter them. The whole process is so fast that the language is just as interactive as BASIC. Once a word has been compiled into the FORTH 'dictionary' it can be used in an immediate mode, without further compilation. This makes program development much faster than with languages like Pascal that need a separate compilation cycle every time a change is made.

Structured. FORTH is inherently a structured language, with all the advantages this implies. For example, as far as I can tell, it is impossible to use the GOTO construction in FORTH. That is not to say that you cannot write bad FORTH programs...

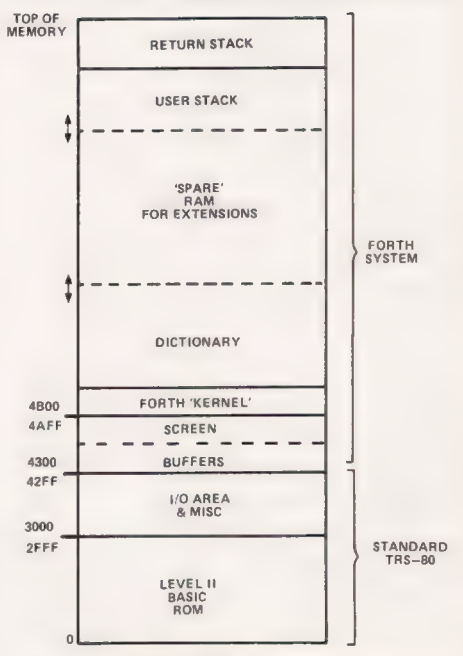

Fig. 1. The MMSFORTH memory map as implemented on a Video Genie.

Transportable. Through the efforts of its developers, Forth Inc. (!) and the International FORTH users Group (IFUG), all the implementations of the lanuguage are very similar, and programs can easily be moved from one system to another. After all, when you can define a language to suit your requirements, dialect problems tend to disappear overnight.

Quick Development. Program development is very quick with FORTH — once you are used to the language, it is probably faster than writing in BASIC. One of the reasons for this is that the more programs you have written, the more words you have created which you can draw on for further programs.

Flexibility. Because of its user-defined nature, FORTH is enormously flexible, and its vocabulary can be matched precisely to a task's requirements.

...And Cons

However, nothing is perfect and, inevitably, FORTH has disadvantages. The main ones are:

Readability. FORTH programs tend to be very hard to read (but not to write). This is partly because you can do an awful lot with just a few words and partly because the language's syntax is, to say the least, unusual.

Integer Arithmetic. Most FORTH systems are integer-only. On the other hand, MMSFORTH supports double-precision integers (±2,147,483,648) and its disc-based version has a floating-point option. Actually, how many programs you write are in, or could be in, integer arithmetic? Probably, like mine, a large proportion.

Unfamiliarity. FORTH's poor readability is partly a result of its unfamiliar approach. It works through a pair of user-accessible stacks, and uses Reverse Polish Notation (RPN). (Keep reading!). On the other hand, anyone who has used a Hewlett-Packard calculator will immediately be at home with the language, **(or those following the Number Crunching articles in Computing Today, Ed).**

Error-Trapping. FORTH gives the programmer an astonishing degree of freedom of access to the computer hardware; in this respect it is assembler-like. Unfortunately, this approach tends to sacrifice some of the language's error-trapping possibilities. Grammar and vocabulary errors are spotted as well as with any other language but if for example you are using an array, you must do your own checks to ensure that you aren't going outside its bounds. The inevitable result of such an error would be a crashed system and, probably, a corrupted program. If you'd rather that the computer did all the checking for you, then read no further — FORTH is not for you.

Although FORTH has been implemented on computers of all types, and a micro version first appeared in 1976, it has only become widely used in the last two to three years, and packages are now available for most microsystems. The basic syntax is controlled to some extent by the International FORTH Standards Teams, although the anarchic nature of the language prevents this control from being more than a guiding hand.

Basic Philosophy Of FORTH

At the core of any FORTH system is the DICTIONARY. This is a list of items, each of which defines a FORTH word. Since most words in the language are specified in terms of other words (the whole system is constructed from a handful of core words), a dictionary entry is essentially a list of pointers to other words. These words point to yet more words, and so on; a dictionary of this type is called a THREADED LIST.

Whenever a word is used, the FORTH INTERPRETER executes it by following the pointers. It may help if you imagine the execution of each word as being similar to going down a long line of nested subroutines, but don't carry this analogy too far. The secret of FORTH's extensibility is that, when new words are defined, they are COMPILED directly into the dictionary, which thus varies in size as the program is constructed. The operations system cannot tell the difference between the original and the new words, and the latter simply become part of the language. Fig. 1. shows a simplified memory map of MMSFORTH, which is a typical system.

Unlike a purely interpreted language such as BASIC, the FORTH code that is executed when the program runs is held in its compiled form. However, unlike FORTRAN, the compiler does not produce machine-code; it produces a dictionary entry which must then be interpreted. FORTH's operation is thus a mixture of compilation and interpretation, bringing together, amazingly, the advantages of both approaches.

Once a program has been written and compiled into the dictionary, the source code no longer exists within the system, other than on tape or disc. The code is written in BLOCKS, the block size varies according to the storage medium and the system, but FORTH actually works on groups of blocks called SCREENS. A screen is normally structured as 16 rows of 64 characters — coincidentally very convenient for a TRS-80. In MMSFORTH, blocks are actually the same size as screens, each holding 1024 characters:

Although FORTH's immediate mode by passes the block/screen format, programs are written and loaded by using the system's SCREEN BUFFERS (MMSFORTH has two. Implementations of the language generally use a virtual memory system to make sure that a modified or newly-written buffer is saved before it is overwritten by a new one. Cassette-based virtual memory is something to marvel at!

Before you can run a program, its appropiate screens are read in turn into the buffers, from where the LOAD word compiles them into the dictionary. With a disc-based system, the detail of the screens is hidden to some extent, although it is all too apparent when you use cassettes.

FORTH's most obvious feature, however, is its STACK. All data goes into, comes out of, or is processed in, the system via a Last-In First-Out (LIFO) stack. Before data can be operated on, it must be pushed onto the stack, which leads to the curious (to a BASIC programmer) effect of all words appearing after the data they manipulate.

This is called Reverse Polish Notation (RPN) and is very strange at first. Unless a word explicity does something else, all the operations work on 16-bit data-words; don't get confused with a normal micro's stack operations, which often work on single bytes.

Actually, almost all computers use the stack/RPN approach when they run high-level languages, but the fact is normally hidden from you. In FORTH, however, it stands naked and unashamed. To be honest, this is one of the reasons that FORTH is so fast and undemanding of space — the programmer does the work that other languages' compliers or interpreters do.

The best way to get a proper understanding of RPN is to look at a few examples and try for yourself. It is truer of FORTH than of almost any other language that you must learn by experience.

Basic FORTH Words

FORTH words can be any size and can use any character available on the keyboard. If you really want to, you can define "!?6A/+$" to mean something. Furthermore, spaces are vital; each word must be separated from the next one by at least one space.

At this point, I will define two conventions. Normally in this series the FORTH words will be quite distinct from the rest of the text, but whenever there might be some ambiguity, I will enclose them between double quotes " ". Assuming that there are no typesetting errors, everything between the quotes is FORTH! The second point is that anything that the computer outputs will be underlined — what you type in is not. There is always an implicit ENTER before any output appears.

Basic Arithmetic Operators

FORTH has the four arithmetic operators familiar to all programmers (+ — /*), and they have the usual meanings. You must remember, though, that they operate on the top two numbers in the stack, which must be put there BEFORE the operator is used. Thus you can have the sequence

```
4 5 + OK
```

The OK is the normal FORTH response which indicates that it has done what you told it to do (which may not be what you meant . . .).

What happened? A number on its own means "put this number on top of the stack", so first of all '4' was put on the stack, and then '5' was pushed on top of it. The "+" popped them both off, added them, and pushed the answer (9) back on to the stack (Fig. 2.).

Multipication is much the same:

```
4 5 * OK
```

leaves 20 on the stack.

What about subtraction and division, where the sequence of events is vital? The rule is easy: the number on the top of the stack (the last one) is taken away from, or divided into, the second from top item. The sequences:

```
12 4 - OK
12 4 / OK
```

leave 8 and 3 respectively on the stack.

All these operators take the top two items off the stack, replacing them with a single item, which is the result, and they all follow the pattern of Fig. 2.

LOW MEMORY ↑		5	
STACK	4	4	9
FORTH	4	5	+

Fig. 2. The addition sequence above is also applicable to the three other maths operations.

You can chain numbers and words together almost indefinitely before you hit ENTER. FORTH tackles them strictly from the left, putting numbers on to the stack and manipulating them with the words, and the language does ***not*** use a hierarchy of operators (eg "*" before "+").

For instance, suppose you wanted to calculate:

```
((7+3*2)*6+8)/2
```

The FORTH sequence

```
7 3 2 * + 6 * 8 + 2 / OK
```

would do the job, and leave the answer 43 on the stack. Fig. 3. shows what is happening all the way through this sequence.

Easy, isn't it? Notice that using RPN means that you never need to bracket anything — the stack operations give an equivalent effect — which is characteristic of the notation.

Here is another example. What is left on the stack after

```
3 7 2 1 8 * - 5 8 - / + * OK
```

is finished? Try to work out the answer yourself before you look at Fig. 4.

So now we can put numbers on the stack and manipulate them once they are there. What we can't do yet is output them. The FORTH word "." (yes, a full-stop) is the answer; its job is to take the top number off the stack and print it on the VDU. You can have examples such as:

```
7 20 . 20 OK
7 20 . . 20 7 OK
2 10 + 3 / . 4 OK
2 3 . . . 3 2 STACK EMPTY!
```

Your can see that "." takes no notice of what has gone before — it blindly takes the top number and prints it, removing it from the stack in the process.

In the last example, we tried to print three numbers, but the stack only contained two. The third "." did not find anything and so generated the standard FORTH 'STACK EMPTY!' error message.

LOW MEMORY ↑			2									
		3	3	6		6		8		2		
	7	7	7	7	13	13	78	78	86	86	43	
FORTH	7	3	2	*	+	6	*	8	+	2	/	

Fig. 3. A rather longer calculation as it would appear in the stack.

					8				8					
LOW MEMORY ↑				1	1	8		5	5	−3				
			2	2	2	2	−6	−6	−6	−6	2			
		7	7	7	7	7	7	7	7	7	7	9		
	3	3	3	3	3	3	3	3	3	3	3	3	27	
FORTH	3	7	2	1	8	*	−	5	8	−	/	+	*	

Fig. 4. A really involved operation, just try this in algebraic notation!

That last point leads to a fundamental rule of FORTH programming:

> Always make sure that the stack contains enough numbers or data for your word to work on.

Equally, you must not leave unwanted numbers on the stack. Remember that the stack grows *down* to meet the dictionary growing up — if they ever meet, the system crashes! So:

> Never leave unwanted numbers or data on the stack.

Stack Operators

We can now do basic arithmetic on the stack but, to write effective programs, we also need to be able to manipulate the arrangement of the data on the stack directly. FORTH provides a number of words to meet this need.

DUP. DUP is used to make a copy of whatever (16-bit word) is on top of the stack, and push it on top of the original. This gives, for instance, an easy way of calculating a square:

```
16 DUP * .  256 OK
```

SWAP. One of the secrets of good FORTH programming is to do as much as possible on the stack, and to use the minimum number of named variables. SWAP is a word that makes this much easier by literally swapping the top two numbers on the stack:

```
10 6 - .  4 OK
10 6 SWAP - .  -4 OK
```

OVER. We can go one better than SWAP by using OVER, which takes a copy of the second item, and puts it on top of the original top item. Thus we could calculate by:

```
(10-6)*10
10 6 OVER SWOP - * .  40 OK
```

Fig.5. shows what is going on here.

ROT. The ROTate word takes things even further by rotating the top 3 items on the stack. The third item is removed, and pushed on top of the original top two items to become the new top-of-stack (TOS). Hence:

```
2 3 4 ROT - * .  6 OK
```

If you are confused at this point, Fig 6 may help. Later in this series, we'll see some examples of ROT in use.

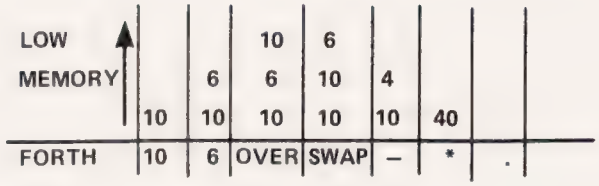

Fig. 5. The SWAP and OVER operations.

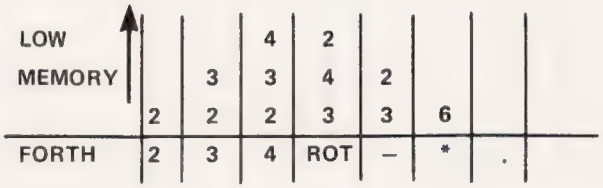

Fig. 6. You can even ROTate the contents.

DROP. It is sometimes useful to be able to 'lose' the top item on the stack. DROP does just that — it pops it off and forgets about it.

The examples above are really very trivial, and it may be hard to see the point of the stack operators. However, their value will become obvious when we start to define new words, and try to do more complex things with the language next month.

Conclusions

That, then, is a first look at FORTH. I've explained that it has many advantages over 'conventional' languages such as BASIC or even (sacrilege!) Pascal. It does, however, need a whole new way of thinking about problems, and you can see that it's not a very easy language to read. You sometimes have to spend a lot of time trying to work out what's on the stack when, and why.

In this month's article, we've only taken a look at FORTH's most fundamental operations: those which do arithmetic and those which manipulate the stack. All the little bits of code have been in the immediate mode — type them in, press ENTER, and there is the answer.

Next month, we will start to look at the use of constants and variables in FORTH, and the definition of new FORTH words in order to extend the language. We will also look at the way that the language provides the fundamental structures of any real program — decision making and looping.

Later in the series, we will go on to see what a typical FORTH program looks like by using the language to solve the classical computing problem of 'The Towers Of Hanoi'. The program will demonstrate just what is involved in writing a FORTH program, and how the programming techniques might be different from those used in, say, BASIC. The 'Towers' program will also give a convincing display of just how fast the language runs.

BENCHMARK	FP BASIC	INTEGER BASIC	FORTH
FOR Loop	2.6	1.8	0.165
Loop on comparison	11.3	9.5	0.435
Variable Arithmetic	26.6	27.2	3.1
Constant Arithmetic	27.8	27.0	3.2
Constant Arithmetic and Subroutine	31.2	30.0	3.3
Constant Arithmetic and Nested Loop	50.6	45.1	4.2
Constant Arithmetic with Nested Loop and Array Manipulation	78.1	69.3	5.6

Table 1. Timings for the FORTH Benchmarks in seconds

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Although primarily designed for the Sinclair ZX81, many of the cassettes are suitable for running on a Sinclair ZX80 – if fitted with a replacement 8K BASIC ROM.

Some of the more elaborate programs can be run only on a Sinclair ZX Personal Computer augmented by a 16K-byte add-on RAM pack.

This RAM pack and the replacement ROM are described below. And the description of each cassette makes it clear what hardware is required.

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The 8K BASIC ROM used in the ZX81 is available to ZX80 owners as a drop-in replacement chip. With the exception of animated graphics, all the advanced features of the ZX81 are now available on a ZX80 – including the ability to run much of the Sinclair ZX Software.

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Cassette 1 – Games

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SNIPER – you're surrounded by 40 of the enemy. How quickly can you spot and shoot them when they appear?

METEORS – your starship is cruising through space when you meet a meteor storm. How long can you dodge the deadly danger?

LIFE – J. H. Conway's 'Game of Life' has achieved tremendous popularity in the computing world. Study the life, death and evolution patterns of cells.

WOLFPACK – your naval destroyer is on a submarine hunt. The depth charges are armed, but must be fired with precision.

GOLF – what's your handicap? It's a tricky course but you control the strength of your shots.

Cassette 2 – Junior Education: 7-11-year-olds

For ZX81 with 16K RAM pack

CRASH – simple addition – with the added attraction of a car crash if you get it wrong.

MULTIPLY – long multiplication with five levels of difficulty. If the answer's wrong – the solution is explained.

TRAIN – multiplication tests against the computer. The winner's train reaches the station first.

FRACTIONS – fractions explained at three levels of difficulty. A ten-question test completes the program.

ADDSUB – addition and subtraction with three levels of difficulty. Again, wrong answers are followed by an explanation.

DIVISION – with five levels of difficulty. Mistakes are explained graphically, and a running score is displayed.

SPELLING – up to 500 words over five levels of difficulty. You can even change the words yourself.

Cassette 3 – Business and Household

For ZX81 (and ZX80 with 8K BASIC ROM) with 16K RAM pack

TELEPHONE – set up your own computerised telephone directory and address book. Changes, additions and deletions of up to 50 entries are easy.

NOTE PAD – a powerful, easy-to-run system for storing and retrieving everyday information. Use it as a diary, a catalogue, a reminder system, or a directory.

BANK ACCOUNT – a sophisticated financial recording system with comprehensive documentation. Use it at home to keep track of 'where the money goes,' and at work for expenses, departmental budgets, etc.

Cassette 4 – Games

For ZX81 (and ZX80 with 8K BASIC ROM) and 16K RAM pack

LUNAR LANDING – bring the lunar module down from orbit to a soft landing. You control attitude and orbital direction – but watch the fuel gauge! The screen displays your flight status – digitally and graphically.

TWENTYONE – a dice version of Blackjack.

COMBAT – you're on a suicide space mission. You have only 12 missiles but the aliens have unlimited strength. Can you take 12 of them with you?

SUBSTRIKE – on patrol, your frigate detects a pack of 10 enemy subs. Can you depth-charge them before they torpedo you?

CODEBREAKER – the computer thinks of a 4-digit number which you have to guess in up to 10 tries. The logical approach is best!

MAYDAY – in answer to a distress call, you've narrowed down the search area to 343 cubic kilometers of deep space. Can you find the astronaut before his life-support system fails in 10 hours time?

Cassette 5 – Junior Education: 9-11-year-olds

For ZX81 (and ZX80 with 8K BASIC ROM)

MATHS – tests arithmetic with three levels of difficulty, and gives your score out of 10.

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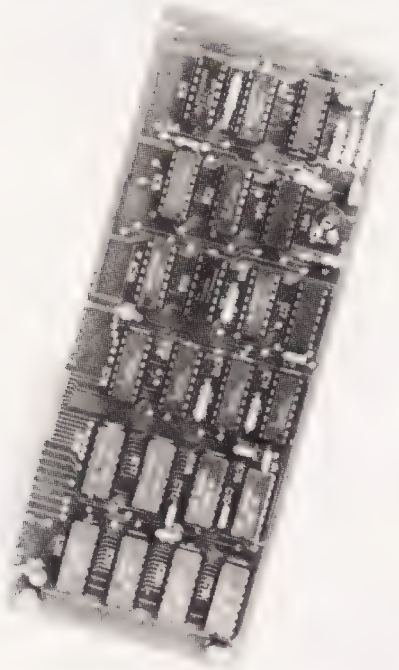

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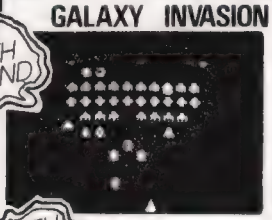

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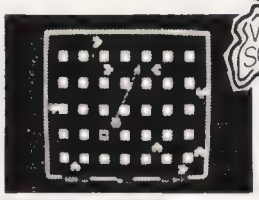

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Peter Freebrey

Our series for first time programmers continues this month, introducing the BASIC equivalent of looping-the-loop, the FOR....NEXT statement.

In order to program a computer it is necessary to be able to communicate with it. As we have already pointed out, the number of 'words' which the computer will initially recognise in BASIC is fairly limited, in all probability it will be less than a hundred 'words'. Of these hundred, some twenty or so represent the most often used and with just these twenty some really good programs can be written. Just look at the programs within the pages of this magazine to convince yourself. Here is the basis for our introduction to programming...first learn this limited number of key words and you are well on the way to writing your own programs.

So far we have looked at PRINT, which enables you to instruct the computer to display information ***to*** the user and INPUT, which in turn instructs the computer to obtain information ***from*** the user. We will now take a small diversion through FOR...NEXT loops.

Looping The Loop

The FOR...TO... statement combined with a NEXT statement creates a LOOP so that the portion of the program between these two statements is repeated a specified number of times. Let us look at an example:

```
10  FOR I=1 TO 4
20  PRINT "HAPPY ";
30  NEXT I
40  PRINT "... BIRTHDAY"
50  END
```

If we RUN this program we will see displayed on the screen:

```
HAPPY HAPPY HAPPY HAPPY ... BIRTHDAY
```

In line 10 immediately following FOR is variable I, this ***must*** have a numerical value and may take the form A,B,F1,X3,AA,DL etc. Subscripted (array) variables of the form A(1,2) or B(2,3,5) are ***not*** acceptable. On reaching line 30 (NEXT I) the computer will loop back to line 10 (FOR I...), increment I by one and execute the loop again. If I has been incremented and its value exceeds the limits for I as set by program line 10 then the program will jump to the statement following the NEXT I; in the above example, line 40. The starting value and limit for I are set by FOR I = 1 TO 4. In this example the loop is executed four times when I has the value 1,2,3,4. Exactly the same result would have been achieved if line 10 had been FOR I = 9 TO 12 or FOR I = 1999 TO 2002. The variable following FOR will always be incremented by one unless specifically instructed otherwise by using the BASIC command STEP, in which case the variable is incremented by the amount specified. If we replace line 10 by any of the following, the same result is displayed.

```
10  FOR I=1 TO 7 STEP 2
    FOR I=234 TO 285 STEP 17
    FOR I=8 TO 5 STEP-1
    FOR I=1 TO 1.3 STEP 0.1
```

Most versions of BASIC will also accept variables or (formulae) as the defined limits and STEP value so you may be able to use something like:

```
10  FOR I=X TO Z+22 STEP B
```

A FOR...TO statement ***must*** be followed by a NEXT statement and it is the program area within these two statements that is repeated as the program loops. There are certain rules that must not be broken for this looping to occur (logically).

The following will result in the loop being executed ***once*** only.

```
10  FOR I=10 TO 5
    FOR I=10 TO 10 STEP 0
    FOR I=10 TO 15 STEP-1
    FOR I=10 TO 10
```

Now I can hear you saying, 'surely no-one would be so dumb as to write a program line like that' ... BUT remember that this line:

```
10  FOR I=A TO B STEP C
```

looks quite reasonable, but what defines the value of A,B, and C? Elsewhere in the program there could be an operation that could bring about 1) — 4) above — be warned.

You may use the variable following FOR within the loop so:-

```
10  FOR K=1 TO 20
20  PRINT K,"OUNCES=";K*28.35;" GRAMS"
30  NEXT K
40  EN
or:
10  FOR K=1 TO 16
20  PRINT "THE SQUARE OF ";K;" = ";K^2
30  NEXT K
40  END
```

But your computer can only recognise one variable named K at a time, so you ***must not*** alter the value of K within the loop. A line like this:

$$25\ K = K - 1$$

would really spell disaster to your program. Again remember this is shown here in a very simple and direct fashion and would obviously stand out like a sore thumb, but if you get into the habit of using certain letters as FOR...NEXT variables and then one day you incorporate a standard formulae that also uses a common letter...

```
10  FOR I=1 TO 20
 :
 :
60  V=I/R
 :
 :
120 NEXT I
```

it can happen!

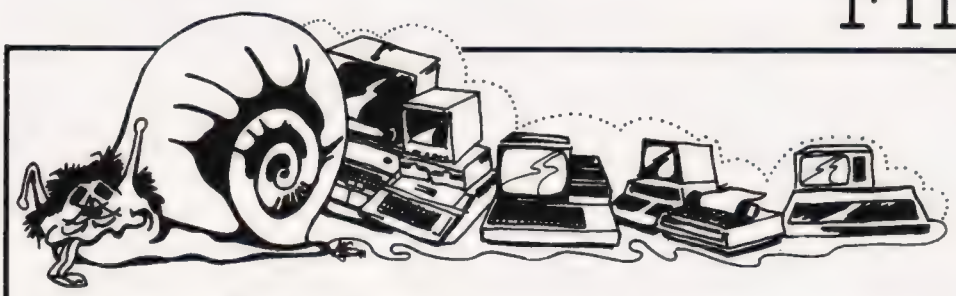
It is quite common to instruct the computer to jump from one program area to another. (We will come to these instructions at a later date.) You may jump ***out*** of FOR...NEXT loop but ***never*** into such a loop. The rules concerning the use of FOR...NEXT loops are all perfectly logical but as programs become more complex it is surprising how often one can fall into one of the traps listed above.

Nesting Time

It is perfectly acceptable to NEST these loops within other loops, just how many nested FOR...NEXT loops depends upon your type of computer, but regardless of how many they ***must*** be nested like those wonderful Russian 'Matroshka' dolls — one complete doll within another complete doll within another...and so on:-

```
10  FOR A=1 TO 4
20  FOR B=1 TO 3
30  FOR C=1 TO 3
40  PRINT A+B*C
50  NEXT C
60  NEXT B
70  NEXT A
80  END
```

```
10  FOR A=1 TO 4
20  FOR B=1 TO 3
30  FOR C=1 TO 3
40  PRINT A+B*C
50  NEXT A
60  NEXT B
70  NEXT C
80  END
```



Slowing Things Down

Not only is the FOR...NEXT loop useful for performing a repetitive calculation with progressive alterations of one or more variables — thereby perhaps optimising the value of the result obtained from a calculation — but it can also be used in several simple routines which are seen in program after program. One of the most common uses of the FOR...NEXT loop is as a time delay. When presenting results on the screen it is often best to display one or two results at a time, spaced out so that they may be clearly read and understood. This means that the program will call for PRINTing perhaps a line or two of text, a result, a couple more lines of text and a further result. The screen is then cleared and this little sequence repeated with another set of results. As the computer can process information and calculations so rapidly, the above procedure could result in the text and results remaining on the screen for too short a time for us mere humans to assimilate. If you insert the following lines before the Clear Screen command, the computer will execute this command taking a time proportional to X. This gives you time to read what you have so carefully programmed the computer to display!

```
200  FOR T=1 TO X
210  NEXT T
```

X may be any numeric value. Each different type of computer will have a different execution speed but as a rule of thumb, start with the assumption that if X = 1000 the time delay will be in the order 1-3 seconds. Time delays of this nature are also very useful in games and teaching programs, allowing only a fixed time in which to make a decision or answer questions. X in this case may be INPUT earlier in the program, so giving a variation in the required response time.

It is well worth timing your computer for a 1 to 10000 FOR...NEXT loop. Say this took 16.5 seconds, if you assign DL = 10000/16.5 it becomes very easy to program accurate delays:

```
10  DL=10000/16.5
 :
 :
80  FOR I=1 TO DL       1 SECOND DELAY
    FOR I=1 TO DL*10   10 SECOND DELAY
    FOR I=1 TO DL/2    .5 SECOND DELAY
```

Next month we will look at the FOR...NEXT loops used in conjunction with READ and DATA statements as an alternative means of INPUTing information to the computer.

AT LAST!

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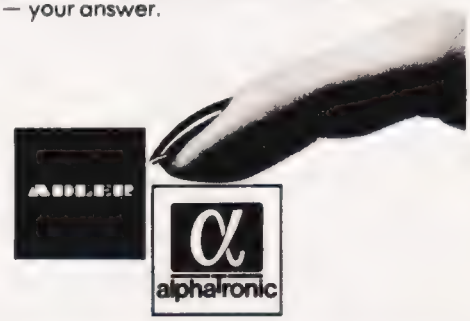

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Mike James

The quantum jump from programming in BASIC to programming in assembly language is well covered in print. We take a look at some of the material available.

The most frequent question asked about assembly language programming is 'what book do I need to get started?'. After mastering BASIC or some other high level language (see recent Book Pages) the attraction of using assembler is strong. The novice programmer is forever being 'put in his place' by the more advanced programmer saying, 'that's best done in assembler', or 'why not move on to something a little more difficult — try assembler'. Sometimes the point is brought home more forcibly by a 'professional' program doing something amazing, usually a very fast graphics display, and a quick look in the software catalogue reveals that machine code is the key to success. So the next step is to learn machine code/assembly language, but how? A check through the book lists yields a wide range of titles like 'Z80 Guide', '6502 Cookbook', 'Introduction to the 8080' etc.

First, Find Your Micro

To know which book you need, you must first identify the microprocessor buried deep within your microcomputer. This can usually be discovered by a quick look through the manufacturer's specifications. For example, the PET, VIC, ATOM, Proton, UK101, Superboard, Apple and AIM are 6502s and the ZX80/81, Video Genie, Tandy, SuperBrain are Z80s, DAI and TUSCAN are 8080s, and SWTPC, MSI, SSB are 6800s or 6809s. Armed with this information we can narrow down the choice to the books referring to your particular microprocessor. However, this is not the complete solution, for, although you may acquire a book about the 6502, it usually makes no reference to your computer system. This matters because although all 6502s are the same, and use the same instruction set, the way in which you can gain access to machine code depends on which microcomputer depends on two factors

1) The microprocessor you're using
2) The 'operating environment' provided by your microcomputer.

Most assembly language books deal only with the first requirement. They'll tell you about an ideal microprocessor with no reference to how you get the assembly language programming examples to run on your particular machine. How do you find out about the second requirement? If the documentation that came with your machine was particularly complete then it might contain a section called 'machine code programming' which will give you the details you need, although they usually manage to leave something out! Alternatively, the manual that comes with your assembler will tell all. What, you haven't got an assembler?! Then that's your problem, an assembler is simply a program that takes the mnemonic codes which humans find easy (?) to understand such as JSR (jump to subroutine) and convert it to a number that computers find easy to understand. An assembler is necessary for any serious assembly language programming and makes learning assembler easy. So, my recommendation is to make an act of faith and buy an assembler for your machine even if you, at present, fear assembly language programming.

Not One But Several

Having suggested that you consider buying one of the standard works of reference, I'll now turn the spotlight on some of the books available. Our first book is in fact a series! Back in the early days of microprocessors, a little known expert wrote a number of books with similar titles, **Z80 programming for logic design, 8080 programming for logic design** etc. The expert was Adam Osborne who went on to become quite well known! The 'programming for logic design' books were really for engineers wanting to come to grips with the 'new' technology. They did have a lot of software information, however, and were invaluable at the time. For programmers, most of the hardware information was simply a nuisance and so Osborne published a new series called **Z80 assembly language programming**, etc. These are written by Lance Leventhal but contain large chunks from the earlier series. To date, there are six volumes covering the **8080A/ 8085**, the **6502**, the **6800**, the **6809**, the **Z80**, and the **Z8000**. Each book follows an almost identical course — only the names and instructions are changed. So although each book in the series is very thick, buying more than one of them quickly leads you into diminishing returns. I find the overall layout of the series a bit off-putting. Each instruction is described with the aid of diagrams that look like spiders crawling across the page (and sometimes spinning a web on the way!) The text is printed in two typefaces, a bold type face spells out the important points and a lighter type expands on the idea. Initial chapters deal with the general concepts of assembly language, chapter 3 of each volume gives the full instruction set, and later chapters include practical examples — each chapter including worked examples and problems (with the results supplied) for the reader to apply the principles already explained to slightly modified conditions.

In my opinion, these texts are not really for the hobbyist. Their dense style is altogether too work-a-day. The only glimpse of levity is provided by the colourful front covers of the first four in the series — but I'm puzzled by their illustrations. That on the 8080A/8085 one seems to suggest a warrior from a Star Wars set!

Rodnay Zaks is a name well known in the world of microcomputers and he too has produced a series of volumes, each devoted to programming a single microprocessor. This is admittedly a much smaller series — just covering the 6502 and the Z80 with a similar volume about the Z8000 written by Richard Mateosian — and it is published by Sybex. Zaks uses a much cleaner, neater layout and devotes whole pages to each instruction of the instruction set. I find his diagrams in the instruction set better than Leventhal's, but I still don't think they add much. Again, his volumes reproduce word-for-word large chunks of text — the whole of chapter one, for example, dealing with 'basic concepts' such as flowcharting and binary arithmetic. Chapter 2 of each is devoted to hardware organisation, chapter 3 to fundamental programming techniques and chapter 4 to the instruction set. The topics in later chapters

are advanced techniques, input/output techniques and devices, applications examples, data structures and program development.

I prefer Sybex's presentation to that of the Leventhal equivalents, and at current list prices they also work out slightly cheaper. Sybex books are distributed in the UK by Computer Bookshop so if you have trouble in getting hold of any of their titles get your local bookshop, or computer supplier, to obtain stocks from Computer Bookshop, 30 Lincoln Road, Birmingham.

The Z80 Microcomputer Handbook is not one of a series, which is unfortunate because it is an attractive book. Hardware details are covered in chapters one to three and Z80 based systems are reviewed in chapters 17 and 18. The main part of the book is about software, however. The instruction set of the Z80 isn't treated in alphabetical order but in logical groups. This makes the book more useful as a tutor rather than a handbook. Chapter 16 lists and explains some common Z80 subroutines — none are very long but it is nice to see how someone else would write them. This is a book that a hobbyist would find useful. It isn't too mind-boggling at first glance and it proceeds at a reasonable pace. It is far slimmer than the previous two books on the Z80, but it still covers almost as much ground.

The books we've discussed so far have been about microprocessors rather than microcomputers. For the beginner there is nothing better than a book based on the machine he will be using. The trouble is that, to date, there just isn't a book for every machine on the market.

If you've got a TRS-80 or a Video Genie and want to learn to program the Z80 inside then I can wholeheartedly recommend **TRS-80 Assembly Language** by Hubert S Howe Jnr. It is well written and succeeds in being easy to understand without 'talking down' to you. The book had its origins in a series of articles in TRS-80 Monthly News Magazine and is typeset using a TRS-80 and a Diablo daisy wheel printer. It is divided into two sections — 'basic concepts' and 'practical programming'. The basic concepts section starts at machine code and the Z80, and ends up discussing the memory map of the TRS-80, including details of the BASIC ROM. The practical programming section assumes that you have the Tandy editor/assembler program right from the start so there is no PEEKing or POKEing to get programs running. However, this doesn't mean that Howe forgets that the TRS-80 is a BASIC machine. A chapter is devoted to USER subroutines and two chapters tell you nearly everything you could want to know about TRSDOS and disc files. If you read this book you will not only become familiar with the Z80 but also with the inner depths of the TRS-80. What more can I say except; please Mr Howe can we have a volume two?

Apple Machine Language by Don & Kurt Inman is on basically similar lines to the TRS-80 book. It is at a simpler level and has strange little cartoons to try to make things clear. Another difference is that the use of an assembler is not emphasised. This has the drawback that unnecessary complications are introduced. For example, having to calculate the relative address for branch instructions. However, I can appreciate the authors' desire to avoid the use of an assembler, since most Apple owners would find it difficult to choose among the various assemblers on the market.

Machine language programs are entered by four different methods: via BASIC PEEK, POKE and CALL instructions; via a small BASIC program ominously called BOS; via the Apple system monitor; and finally, via the Apple mini assembler. This last method is not, however, relevant to owners of Apple II Plus systems since the mini assembler is not included in the APPLESOFT ROM. One good thing about this book is that it gets you writing machine code programs very quickly. This is achieved by the use of the subroutines in APPLESOFT BASIC, so the first programs you write will look like a list of subroutine calls. A program that plots dots on the screen and plays the musical tones corresponding to them (eg an ascending scale), seems a novel and amusing approach to machine code. If you own an Apple and want to learn about assembly language then this book will help, but be prepared to work hard.

Tony Baker's **Mastering Machine Code on Your ZX81** is written for 'people who have a reasonable understanding of BASIC, but whose knowledge of machine code is zero'. It is a comprehensive and clear account. It needs to be read from cover to cover, with your ZX80/1 at your fingertips, but I found it kept my interest and was not difficult. The style is casual, sometimes in the extreme, but I liked the feeling that the author had actually ***used*** a ZX80/1 and had made mistakes along with the rest of us. The programs used as examples are many and interesting in themselves, they are mainly games (again draughts is included), or other examples that fall into the category of 'light stuff', eg programs that play music or do graphics. However, the final two chapters cover more serious topics, ROM disassembly and floating point arithmetic (using the ROM subroutines). I would have no hesitation in recommending this book to Sinclair devotees — it will indeed help you to get the most out of your machine.

The books covered this month were:

Assembly Language Programming Series, by Lance A Leventhal, published by Osborne (McGraw Hill).

8080A/8085	1978	500 pages	£11.60
6800	1978	500 pages	£11.60
6502	1979	650 pages	£12.10
Z80	1979	640 pages	£12.10
Z8000	1980	900 pages (with Adam Osborne and Chuck Collins)	£13.60
6809	1981	680 pages	£12.10

Programming the 6502, by Rodnay Zaks, published by Sybex, (1980), 392 pages, £10.25.

Programming the Z80, by Rodnay Zaks, published by Sybex, (1981), 620 pages, £11.50.

Programming the Z8000, by Richard Mateosian, published by Sybex, (1980), 312 pages, £12.10.

The Z80 Microcomputer Handbook, by William Barden, published by Sams (1978), 304 pages, £5.70.

TRS-80 Assembly Language, by Hubert S Howe, published by Prentice Hall, (1981), 186 pages, £7.45.

Apple Machine Language, by Don and Kurt Inman, published by Reston (Prentice Hall), (1981), 296 pages, £6.45.

Mastering Machine Code On Your ZX81, by Tony Baker, published by Database Consultancy, (1981), 180 pages, £5.95.

(*Modesty has prevented Mike James from promoting his own volume on the 6809, **The 6809 Companion**, which will be published in the new year by Babani at the amazing price of £1.95 for 96 pages. Ed.*)

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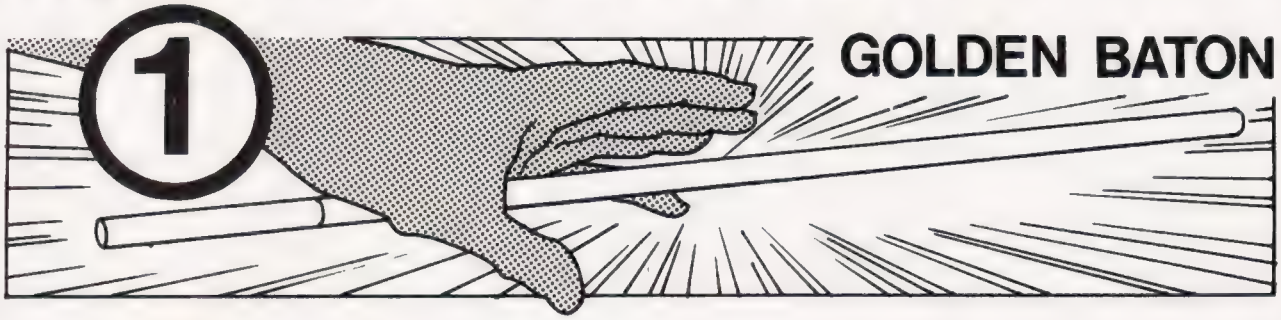

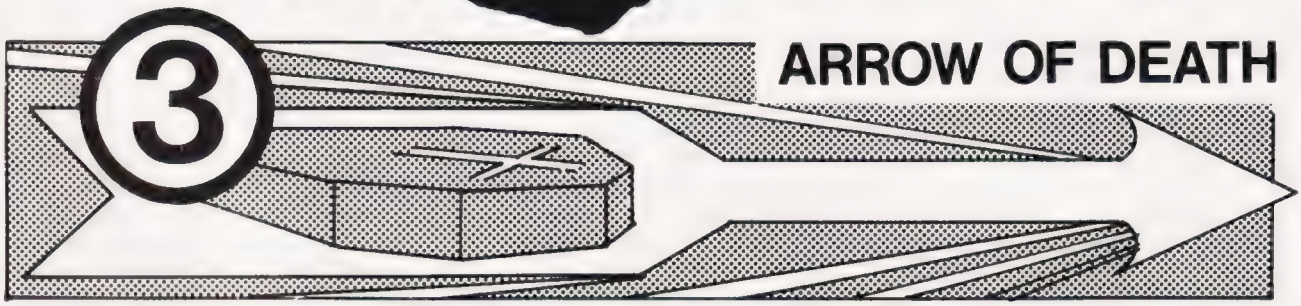

Three months ago we introduced the Mysterious Adventure series, a brand new series of machine language Adventures written by Brian Howarth. The first one, The Golden Baton, was greeted with enthusiasm by experienced and beginner Adventurers alike. Now the second and third in the series, The Time Machine and Arrow of Death, are available. The Arrow of Death, although entirely self-contained, is the first of a two part Adventure. The second part will be available early in the new year.

Mysterious Adventures are available for Models I and III TRS-80 and Models I and II Video Genie, both on tape (16K minimum) or disk (32K 1 disk minimum). A TRS-80 Model II version will be available shortly.

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The introduction of a brand new word processor is a major event and AJEDIT is without doubt a major program. There are, however, quite a few Word Processors around and most of them are extremely good ones - why, therefore, another? The question is even more pertinent when it is known that we specifically commissioned the writing of it from an author of the status of Denville Longhurst of Enhanced Basic fame. The answer is that user feedback shows that a large number of customers do not need or want word processor programs which require a quantity of training before use. Scripsit, for instance, is an excellent program, but is complex to use; it even comes with a training course on tape. If one operator is dedicated to using the word processor then it makes sense to have her trained, and the more complex the program (so long as the complexity is accompanied by more and bigger functions) the better.

AJEDIT has been written for the user who needs a word processor intermittently, say three or four times a week. Its prime design criteria was ease of use - and just as importantly - ease of recollection of its commands. Take, for instance, the text editing commands - they are as close to the Basic Edit commands as possible, so that the user will remember them: To insert type I, to delete D, to take out three letters type 3D and so on.

Furthermore, AJEDIT has benefited from being written after a number of other word processors. The deficiencies in its predecessors are corrected in AJEDIT. For instance, any control characters can be outputted so that full advantage can be taken of the features of the particular printer being used. Disk directory access is available from within AJEDIT as is the killing of files on the disk. The FREE command and a number of other DOS commands can be carried out from within the program with a return to AJEDIT - with its text intact.

AJEDIT contains close to one hundred commands covering most word processor requirements. Dedicated printer commands for the Epson MX series and the Centronics 737 are included - again for ease of use of these two popular printers.

One of the big features of AJEDIT is the ability to "mail-merge". The facility is available whereby two special files are created, one containing names and addresses and a salutation. the other a standard letter or form. AJEDIT will call the address and salutation from one file and the letter from the other and thereby compile personalised letters. The salutation may be repeated in the body of the letter.

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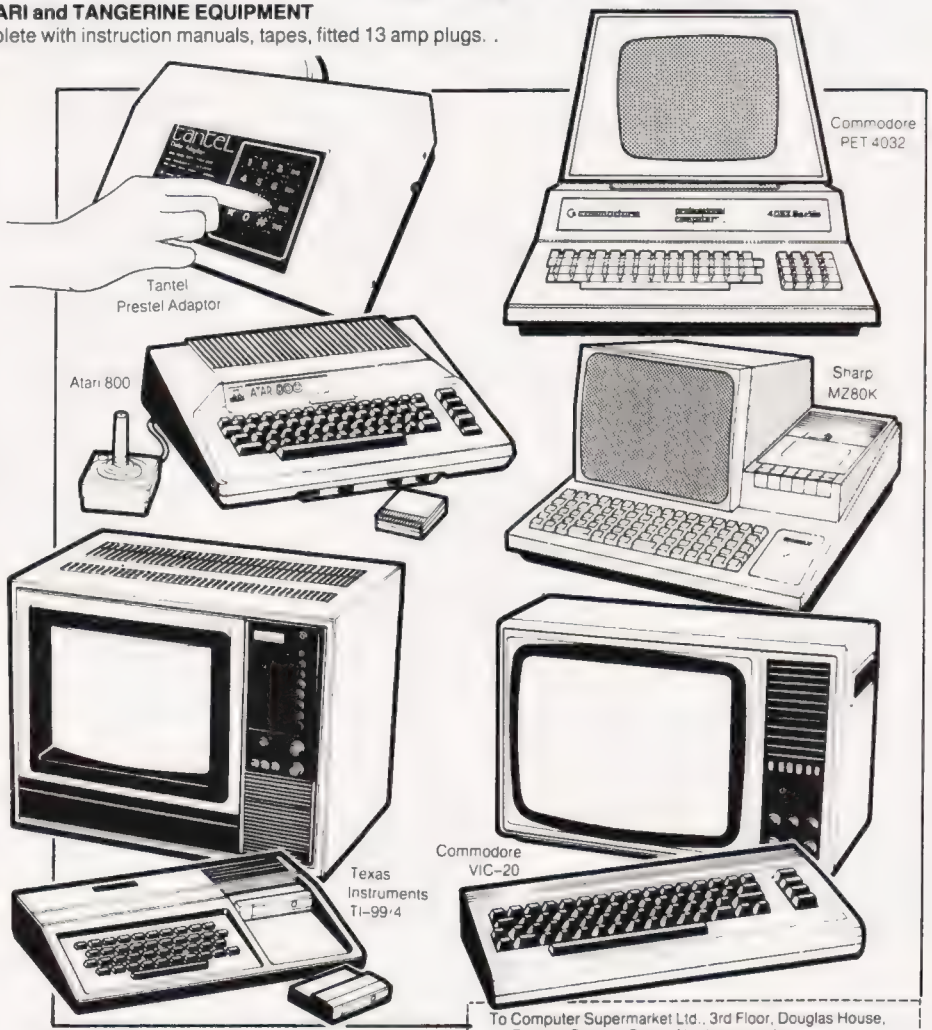

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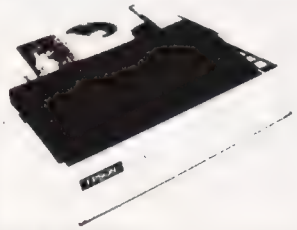

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Mike James

NUMBER CRUNCHING

In the second part of his article on how to process arithmetic expressions, Mike James shows you how to use this as part of your own compiler.

Micros are awful at arithmetic! They can just about manage addition and subtraction, but division and multiplication are usually beyond them. It's obvious that if we are going to evaluate arithmetic expressions, something has to be done about this situation. The usual solution is to write machine code subroutines to carry out each of the four simple operations of arithmetic. This set of routines is often referred to as a 'maths package' and there may be one available for your microprocessor already. If there is, then the best thing to do is to buy it! Otherwise you've got a lot of work to do in writing one.

Maths packages generally come in two sorts!

1) Floating Point
2) Integer

Floating point packages carry out arithmetic on so-called 'real numbers'. A real number is anything like 3.256, ie it can have a fractional part. An integer, however, cannot have a fractional part. For example 3; 10; −1; 0 are all integers but 3.5; .2; −0.02; 4.0 are all real numbers. Notice that the last example of a real number, 4.0, could be considered to be an integer, ie 4. The point is that you can represent an integer as a floating point number, simply by writing .000 after it, but you cannot represent a floating point number as an integer!

For the rest of this article we will assume that all the arithmetic is done by a 16-bit integer package. The reason for this will become clear as we go on. Briefly, the principles are the same for floating point as for integer and a 16-bit package is easy to write for most micros. With a 16-bit integer the maximum number that we can handle is 32767 and the minimum is −32678, so things are still usefully large.

Compilers And Subroutines

The purpose of a compiler is to take high level language statements and translate them into machine code. There are a number of ways in which this can be done. For example, if we are interested in compiling the statement:

A=B*3

we could use subroutines from the maths package we discussed above and simply generate a subroutine call to multiply B by 3. Some people would say that this was not a true compilation! A true compiler shouldn't avoid the problem of how to do multiplication but should generate the necessary code rather than jumping to a subroutine. Personally I think this argument is silly when applied to a microprocessor. It takes a lot of instructions to do multiplication and to generate them each time is wasteful. From now on the sort of compiler that we will be considering will try to compile high level language into a sequence of subroutine calls. This is sometimes referred to as a 'threaded code' compiler.

If we are going to be generating a sequence of subroutine calls there is another simplification that we can make to our compiler. Instead of translating to machine code we can make use of assembly language. If our compiler produces assembly language we can leave a lot of boring jobs to the standard assembler which is available for every micro. The sort of jobs I'm thinking of are converting decimal constants to binary and looking after the absolute addresses of everything. This may seem a messy way to write a compiler because you need another program, ie the assembler, before you get the final code. The procedure is to run the compiler which outputs assembly language and then use this as the input to an assembler. This approach has a few advantages though; the assembly language output can be altered and added to, using a text editor, and the incorporation of other programs, such as the very necessary maths package, can be done by simply appending the two text files. The criticism that this method is slow is true, but it should be remembered that most compilers have to read through the text of the program a number of times and by using an assembler we can make do with one, or at most two, passes.

Evaluating Reverse Polish

Generating machine code code or assembly language for an arithmetic expression is a matter of following the rules that we gave last month for evaluating Reverse Polish.

> 'Scan the expression from left to right until you meet an operator. When this happens the operator is applied to the two variables to the left. The result is left in the expression replacing all the variables and symbols used to produce it.'

Only, instead of carrying out the arithmetic when we find an operator, we produce instructions that will carry out the arithmetic. For example, consider AB*C+. The first thing we hit is A, then B — neither of which we are interested in at the moment. Then we hit * which means do a multiplication on the last two variables we passed over, ie A and B. So our compiler must output " JSR MULTIPLY". We suppose that the subroutine MULTIPLY can find the last two variables automatically and output its result in such a way that it becomes the last variable passed over. At this point I hope the words LIFO stack are flashing somewhere in the back of your mind! If we stack each variable as we meet it the last two variables are easy to find. They are simply the top two items! So if all our arithmetic subroutines work on the top two items on the stack and place their results back on the stack, everything looks after itself.

Using a stack and a set of stack oriented arithmetic subroutines the evaluation of AB*C+ generates the following code:

```
STACK A
STACK B
JSR MULTIPLY
(This multiplies A and B and puts result
back on the stack)
STACK C
JSR ADD
(This adds C to the result of A*B)
```

Of course, the result is left on the stack but can be easily printed out using another subroutine 'PRINT' which prints and removes the top item on the stack. The instructions

STACK A etc have to be written in whatever assembly language you're using, ie 6502, Z80 etc.

There are other ways of evaluating an arithmetic expression. Some result in faster code and a lower memory use — using a stack results in some unnecessary pushing and pulling and extra copies of data. However, the stack method has the advantage of being simple to implement, easy to understand and, in a lot of cases, not too bad in terms of speed and memory use. Some computer manufacturers have taken this liking of the stack method to its logical conclusion by building computers with no other memory than a stack (or sometimes two).

The Code Generator

If we look at the program for generating 6502 code, it looks very complicated, but the first half from 5000 to 5420 is simply a version of the Reverse Polish converter which was described last month. The only real addition to the original program is the insertion of a blank in front of every constant, ie string of digits. This is done by keeping a count of the number of digits since the last non-digit character (lines 5245-5250 and 5066). The really new section is the subroutine in lines 5500 to 5685. This is the code generator subroutine. The program begins by asking for an arithmetic expression to work on, in line 2. It then calls subroutine 5000 which, using the algorithm discussed last month, converts the string in A$ into Reverse Polish in C$. For interest (and to check that the program is working!) A$ and C$ are printed at line 4. A call on subroutine 5500 generates the 6502 assembly language for the expression. Each instruction is printed as it is generated. A 'real' version of this program would save the instructions on disc or tape for later use by an assembler, but that's something for you to do. If the character is a letter, it is assumed to be a variable. (Notice that we can only handle single letter names.) The names of all the variables are changed to VAR followed by one letter. This is so that other assembly language routines know which names to avoid using. So, lines 5540-5560 generate code to push the variable onto the stack. In the case of the 6502 this has to be done in two attempts because each variable is 16 bits and the 6502 can only move eight bits at a time. For example, if the variable X is found in an expression

```
LDA   VARX
PHA
LDA   VARX+1
PHA
```

is generated. For this to work, it is necessary for some other part of the code generator program to produce

```
VARX  FDB  0
```

to reserve space for the variable. To do this you can either keep a list of all the variables used, or have FDB statements for variables A-Z (all 26 of them). As this latter option uses only 52 bytes, it is obviously the one to use for now.

If the character is a digit, then a constant must be stacked. First we must somehow create the constant. As we are using an assembler, this is easy. Suppose the constant 415 was in the expression, all we have to do is generate something like:

```
C2  FDB  415
```

The assembler would take care of the conversion to binary later! The only trouble is that we have to keep count of how many constants we are using and give them all different names, ie C1, C2, . . .Cn. This is what goes on in line 5572. The constant itself is created in lines 5574 to 5619. In this case it's not good enough to print out the code at once because data storage areas are normally separate from the program. The solution is to use an array, C$ and store the FDB instruction for constant N in C$(N) and print out C$ at the end of the code generation. This is what subroutine 5700 does. After creating the constant all that's left is to stack it and this is done exactly as for variables, in line 5573, only the name used is C1, C2, . . . etc.

Finally, if the item isn't a letter or a digit it must be an operator. Lines 5625 to 5680 check which operator and generate the correct subroutine jump.

The Run Time Package

The assembly language produced by the code generator has to be added to the maths package and the data area declaring the variables (ie 26 FDB instructions). In a complete compiler the code that has to be added to that generated by the compiler is often called the run time package. Although our run time package is small, real packages can be very large — about 12K to 16K — and if you want to go on to produce a compiler in BASIC then be prepared to spend as much time on the run time package.

Conclusion

If you've followed so far you should be capable of going on to write an entire compiler in BASIC. The machine you write it for is up to you — all you need to do is change the run time package and the way subroutines are called and items stacked. (For example, on the 6809 the stacking can be done by LDX 0ARA; PHSS X and for the Z80 subroutine calls are done by CALL ADD.) Even the language you write it for is up to you but there is a very surprising advantage in writing a BASIC compiler in BASIC. Once you've finished your compiler you can (if you've finished it well enough) run the BASIC program that is the compiler through the compiler! The result is a machine code BASIC compiler that runs fast! Another advantage in sticking to BASIC is that one of the most difficult parts of writing a compiler is finding and dealing with errors in programs that you are trying to compile. For example, our code generator would pass things like A(+C without any sign that anything was wrong. It would even generate code for it! If we stick to BASIC then we can forget about trying to track down errors and suppose that all the programs that are to be compiled are error-free. The way that this can be achieved is to run and debug all of them using the BASIC interpreter that the compiler is run under!

As you make progress with your BASIC compiler the LIFO stack will crop up time and time again. After a while you'll wonder how you ever managed without it. When you come to implement FOR...NEXT loops, for example, each FOR instruction can stack the index variable and the value that it must reach to terminate the loop, and each NEXT instruction simply increments the value on the top of the stack and compares it to the limit. This method of implementation takes into account the normal 'nesting' rules for FOR loops automatically.

The evaluation of arithmetic expressions also proves to be of general use. The simple arithmetic operators can be extended to include logical operators, such as AND and OR, operating on Boolean

variables. (A Boolean variable is often implemented as an integer that has two special values, eg 0 and −1, usually referred to as 'true' and 'false'.) Your only problem in using the Reverse Polish stack method is in deciding the priorities to be assigned to the operators. In IF statements, the relational tests (=, <, >, <> etc.) can also be treated as binary operators and similarly evaluated. Their action is to compare the top two items on the stack and place a Boolean variable on the top, indicating whether the relationship is true or false.

After all this it may come as no surprise to discover that it is possible, although not really practical, to convert, in its entirety, any BASIC program to Reverse Polish and evaluate it using the techniques described in these two articles!

$$F(T) = \int_0^T p(x)dx = \int_0^T Ae^{-Ax}dx = 1 - e^{-AT}$$

Program Listing

```
   1  DIM Z(25),W(5),C$(10)
   2  INPUT A$:I=1
   3  GOSUB 5000
   4  PRINT A$,C$
   5  GOSUB 5500
   6  GOSUB 5900
   7  END


5000  U$="-+*/()"
5010  Z$="":C$="":X=1:O=1
5020  W(1)=1:W(2)=1:W(3)=2:W(4)=2:
      W(5)=0
5030  FOR J=1 TO 25:Z(J)=0:NEXT J
5040  IF LEN(A$)<I THEN 5470
5050  B$=MID$(A$,I,1)
5060  IF B$="[SPC]" THEN I=I+1:GOTO 5050
5070  K=0
5080  FOR J=1 TO 6
5090  IF B$=MID$(U$,J,1) THEN K=J
5100  NEXT J
5110  IF K=0 THEN 5260
5120  D=0
5130  IF K=6 THEN 5380
5140  S=W(K)
5150  IF S=0 THEN 5230
5160  IF S=1 THEN 5420
5170  O=1
5180  IF X=1 THEN 5230
5190  IF Z(X-1)<S THEN 5230
5200  C$=C$+LEFT$(Z$,1)
5210  X=X-1:Z$=RIGHT$(Z$,LEN(Z$)-1)
5220  GOTO 5180
5230  Z(X)=S
5240  Z$=B$+Z$:X=X+1:I=I+1
5250  GOTO 5040
5260  O=0
5270  IF B$<"A" THEN 5310
5280  IF B$>"Z" THEN 5310
5290  C$=C$+B$
5300  I=I+1
5310  IF B$>"9" THEN 5040
5320  IF B$<"0" THEN 5040
5330  D=D+1
5340  IF D=1 THEN B$="[SPC]"+B$
5350  C$=C$+B$
5360  I=I+1
5370  GOTO 5040
5380  IF LEN(Z$)=0 THEN I=I+1:GOTO 5040
5390  B$=LEFT$(Z$,1):Z$=RIGHT$(Z$,LEN(Z$)-1):
      X=X-1
5400  IF B$="(" THEN I=I+1:GOTO 5040
5410  C$=C$+B$:GOTO 5380
5420  IF O=0 THEN 5170
5430  S=6
5440  IF B$="-" THEN B$="!"
5450  IF B$="+" THEN B$="?"
5460  GOTO 5170
5470  C$=C$+Z$
5480  RETURN
5490  J=1
5500  IF J>LEN(C$) THEN RETURN
5510  B$=MID$(C$,J,1)
5520  PRINT
5530  IF B$<"A" THEN 5600
5540  IF B$>"Z" THEN 5600
5550  PRINT " LDA VAR";B$
5560  PRINT " PHA"
5570  PRINT " LDA VAR";B$;"+1"
5580  PRINT " PHA"
5590  J=J+1:GOTO 5500
5600  IF B$<"0" THEN 5730
5610  IF B$>"9" THEN 5730
5620  N=N+1
5630  PRINT " LDA C";N:PRINT "PHA ":
      PRINT " LDA C";N;"+1":PRINT " PHA"
5640  C$(N)="C"+STR$(N)+" FDB "
5650  IF B$<"0" THEN 5730
5660  IF B$>"9" THEN 5730
5670  C$(N)=C$(N)+B$
5680  J=J+1:IF J>LEN(C$) THEN RETURN
5690  B$=MID$(C$,J,1)
5700  IF B$>"9" THEN 5520
5710  IF B$<"0" THEN 5520
5720  GOTO 5670
5730  PRINT
5740  IF B$="+" THEN PRINT " JSR ADD"
5750  IF B$="-" THEN PRINT " JSR SUB"
5760  IF B$="*" THEN PRINT " JSR MUL"
5770  IF B$="/" THEN PRINT " JSR DIV"
5780  IF B$="!" THEN PRINT " JSR NEG"
5790  PRINT:J=J+1:GOTO 5500
5900  FOR I=1 TO N
5910  PRINT C$(I)
5920  NEXT I
5930  RETURN
```

This is the Reverse Polish generator from last month with the extra routines necessary to write 6502 code.

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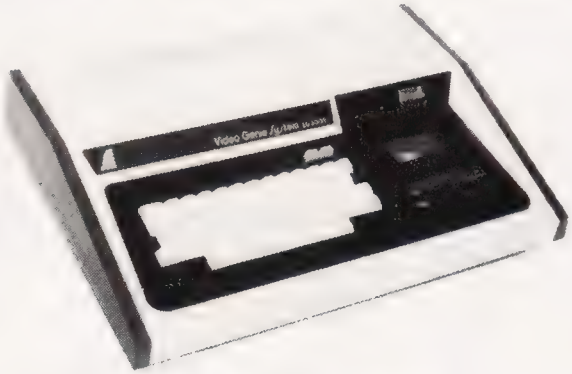

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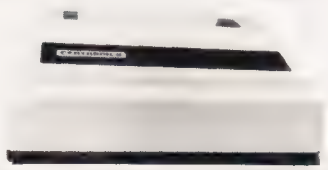

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Henry Budgett

Once again the Editor comes dashing to the assistance of readers with a technical problem.

There's nothing quite like starting off a column like this in a grovelling fashion. It seems that the answer I gave to Mr Deakin's enquiry about the Video Genie is not strictly correct. The Genie normally comes with some 16K of user RAM and this is expandable to 48K by fitting an extra unit on to the system. However, at least one firm, Q Tek to be precise, offer the option of having the Genie with 32K of RAM fitted inside the main unit. I also believe that this expansion capability may be offered as a do-it-yourself option, whether by Q Tek or someone else I'm not yet sure. My apologies Mr Deakin and anyone else who may have been misled. My thanks to Paul Moore of Birmingham for pointing this out.

The Viewdata Option

An increasingly popular interest among the micro fraternity is connecting Viewdata to one's computer. The letter I received from Mr G Hewson of Ickenham is fairly typical.

My interest in micros was sparked by a search for a Viewdata and/or Teletext adaptor. My imagination started working overtime when I came across the Tantel Viewdata adaptor, which can be connected to a micro; this obviously opens up all sorts of interesting possibilities. The interface for the Tantel is CUTS — what is this and how common is it?

What I am looking for is a highly flexible micro system. This would be rack based, into which I could plug various cards. Is there such a system on the market?

In a word, yes. The Tantel unit you mention is being offered with a number of interface options; these include ones for their own computer, Apple, NASCOM etc. The CUTS interface is as near to a 'standard' as one is likely to get for computer tapes. It actually stands for Computer Users Tape Standard and defines the two frequencies used; one to indicate the '1s' and the other the '0s'.

Apart from the unit you mention there are adaptors available for the Acorn ATOM, the Apple and one from High Tech for the S100 bus. Waiting in the wings, as it were, is the BBC Computer which will definitely have a Teletext adaptor available and, almost certainly, a Viewdata unit too.

One other thing is fairly certain, the advance of the Telesoftware project and the increase in awareness of the capabilities of Viewdata, mean that the number of options available is going to go up!

The ASCII Solution

The problems of using odd keys to control one's software seems to arise occasionally and, as you might have guessed, Mr W E F Green of Biggin Hill has a query along these lines.

I have a UK101 and I wish to control the course of a program by using the Control key together with the 'R' or 'T' key.

I'm not quite sure how to do this and any help you can give would be appreciated.

The key, if you'll excuse the pun, to this is to make use of the ASCII codes generated. Given that the UK101 obeys the rules (I'm afraid I haven't got one in the office to try this on), pressing the control key should alter the ASCII code generated by the other key you've pressed.

For example, the ASCII code generated by the 'R' key should be 82 (decimal), the bit pattern for this is 1010010. If you press Control at the same time it strips off the top bit turning the code to 0010010 or 18 decimal. To detect this you will need a piece of BASIC somewhat similar to this:

```
200 INPUT A$
210 IF ASC(A$) = 18 THEN 300
220 IF ASC(A$) = 20 THEN 400
230 GOTO 200
300 PRINT "I JUST FOUND CONTROL R"
310 GOTO 200
400 PRINT "I JUST FOUND CONTROL T"
410 GOTO 200
```

Now, I make absolutely no claims for the elegance of the above but it should give you some idea of what will be required. A note of warning though; you can only apply this rule to the ASCII codes from 64 (@) to 95 (_) without fear of problems arising. Furthermore, a little thought will soon reveal that Control and 'M' will produce the same code as pressing Return!

More Code Confusion

The letter from Mr Green sparked off a dormant memory of the last PCW Show. Whilst attending to the needs of the public, ie selling magazines, one of our readers asked me to explain what the first 32 ASCII codes did. Not being instantly able to recall them all I promised to put him out of his misery and publish the complete list. And, here they are.

Code	Dec	Hex	Function
NUL	0	0	Null
SOH	1	1	Start of header
STX	2	2	Start of text
ETX	3	3	End of text
EOT	4	4	End of transmission
ENQ	5	5	Enquiry
ACK	6	6	Acknowledge
BEL	7	7	Bell (Audible signal)
BS	8	8	Backspace
HT	9	9	Horizontal TAB
LF	10	A	Line feed
VT	11	B	Vertical TAB
FF	12	C	Form feed
CR	13	D	Carriage return
SO	14	E	Shift out
SI	15	F	Shift in
DLE	16	10	Data link escape
DC1	17	11	Device control 1
DC2	18	12	Device control 2
DC3	19	13	Device control 3
DC4	20	14	Device control 4
NAK	21	15	Negative acknowledge
SYN	22	16	Synchronous idle
ETB	23	17	End of transmission block
CAN	24	18	Cancel
EM	25	19	End of medium
SUB	26	1A	Substitute
ESC	27	1B	Escape
FS	28	1C	File separator
GS	29	1D	Group separator
RS	30	1E	Record separator
US	31	1F	Unit separator

Of these the only ones used in general programming are LF, CR, FF and ESC. Sometimes systems will implement the BEL and ESC and others use the DC set to control peripherals. The only devices which will use all the control codes are telecommunications peripherals because this is what they were originally designed for! Please note that the codes can also be generated by using the Control key with the ASCII codes from 40 Hex to 5F Hex as explained above.

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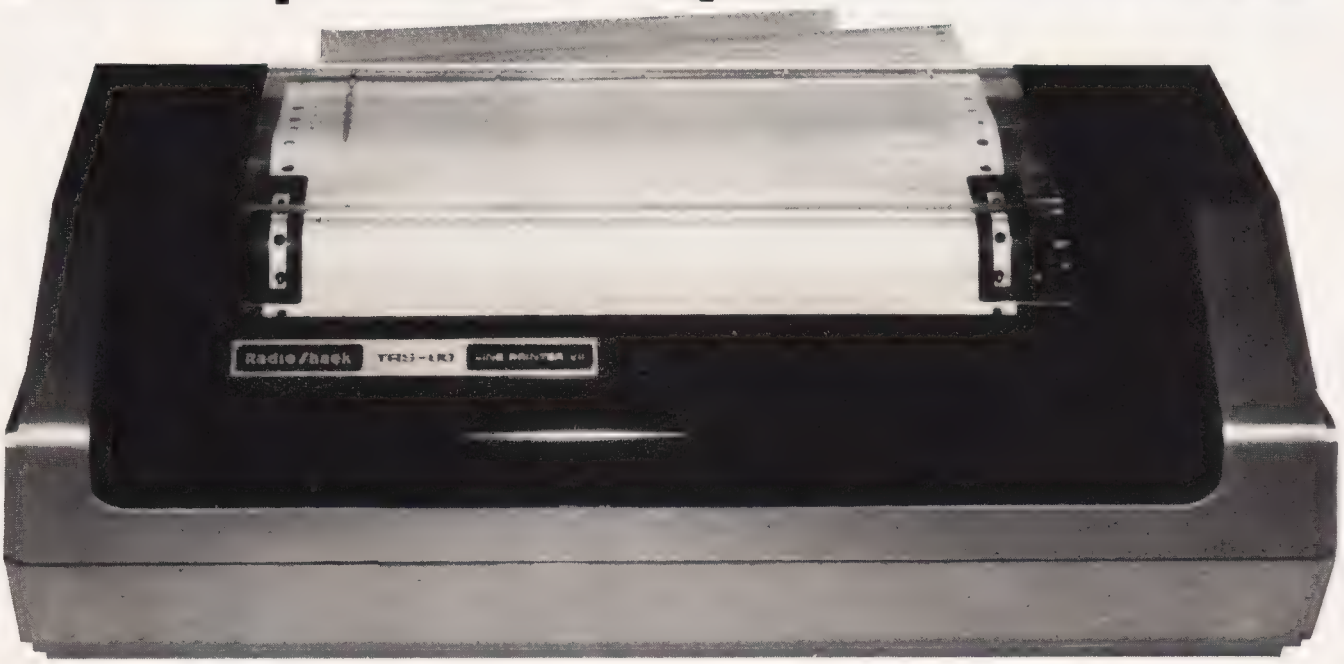
Peter Tootill

SPECIAL REPORT

We take a look at two new dedicated peripherals; the uni-hammer printer from Tandy and Sinclair's ZX Printer.



The new printer from Tandy, called the 'Personal Line Printer', has already awakened quite a bit of interest in the market. At £199 (or £173 + VAT, as most advertisers would say), excluding connecting cables, it is currently the cheapest plain paper printer available in this country. Only its bloodbrother, the Seikosha, comes near it in price. At the time of writing, the latter is about 15% more expensive in its standard version. However, with the pound falling at present, there may well be price rises in the offing on a lot of imported microcomputer equipment.

The Hardware

The new Tandy printer is an 80 column, unihammer, plain paper printer, with double width character and graphics capabilities. It uses tractor feed for standard (9.5″) width paper, and is claimed to handle up to three-part carbonless stationery. There is no provision for friction feed paper rolls or for single sheets. It is also not suitable for adhesive labels, so you couldn't use it to handle a mailing list, for instance. It does, however, have both Centronics parallel and RS-232 serial inputs as standard.

It will be no surprise to learn that the new Tandy printer appears to come from the same stables as the Seikosha. The method of operation (a single hammer) is the same, and the mechanism looks identical. However, there are one or two differences between them, the Tandy is not simply a repackaged Seikosha. Some of these differences are relatively minor. For example, the Tandy takes paper up to the more usual (for microcomputers) width of 9.5″, whilst the Seikosha stops at A4, or 8.5″ wide. The basic character sets are identical, except that the Seikosha prints 12 characters per inch compared to the Tandy's 10, in order to fit the 80 columns on to its slightly narrower paper. Also, both have double width character and graphics facilities but the Seikosha has an additional 32 'European' characters as well as the normal ASCII set of 96. The extra 32 include such things as a pound sign, letters with accents, a sprinkling of Greek letters and a few symbols. The Tandy doesn't even have a pound sign! The chief difference, which will make the Tandy appeal to a wider range of microcomputer owners, is the serial input. This is designed for use with the Tandy 'Colour Computer', which is to be launched in Britain in November 1981. A serial input facility is an optional extra for the Seikosha, and costs an extra £56 (inc. VAT) at current prices. The Tandy machine is somewhat larger and heavier than the Seikosha but both are fairly slow and noisy in operation.

Making The Connection

If you have a serial printer output the connection to the printer is via a four-pin DIN socket rather than the standard 25-pin D style connector, and you will probably need a special cable. However, only three wires are required, and this form of connection will only cost you a few pounds (and five minutes with a soldering iron), compared with £30 for a parallel cable to the Tandy expansion interface. The serial input is to RS-232 standard, operating at 600 baud and seven- or eight-bit word length, eight bits being required for graphics. There is no parity check. The parallel socket does have a self-test pin, but no test switch is provided and there is no 'out of paper' detector.

If you don't have an expansion interface for your Tandy, you can still use the printer by means of a special cable — a similar cable being available for the 'Video Genie'. However, you could put the £40 this would cost towards an RS-232 interface such as the PCR-81 (from '3-Line Computing' in Hull, at about £50), which can be plugged straight into the keyboard and used to drive the printer. You would then have the capability to connect (via an acoustic coupler, or a modem and the telephone) to other computers and networks such as 'Forum 80'. I was unable, however, to make the serial input operate properly in the time available because (I think) of deficiencies in the software I was using.

The 'Line Printer VII' comes well packed, and with reasonable

documentation. It is attractive in appearance, and seems fairly robust and well made. Virtually, the whole of the top of the machine forms a cover which should provide good protection from dust, no other protection being required.

Setting up the printer is straightforward. The edge connector on the cable supplied with the review machine was fitted upside down, but I was warned that this might be the case. Plugging it in the wrong way round would not be likely to cause any damage. The printer ribbon is packed separately and was easily installed without even getting my hands dirty! Having fitted a mains plug and connected the printer to the computer, all that was required was some paper, which is fairly easy to load, and the printer was ready for use.

Printing It Out

The appearance of the output is reasonable but not of the standard of more expensive dot matrix printers, it lacks descenders (surely we could have at least a token effort at including these in this day and age!) and there is a tendency for output to be slightly blurred. This is because of the way that the dots are formed — which is unusual, so I'll describe it in some detail:-

The hammer, which strikes the paper through the ribbon, is a narrow bar seven dots high and not quite vertical. Behind the paper is a rotating roller, called the platten, which has a series of longitudinal ridges running the entire width of the page. Where the hammer and a ridge meet, a point is formed and a dot appears on the paper. After printing the topmost dot of the column, the hammer retracts and strikes the paper again a fraction of a second later, by which time the ridge on the platten has moved to the next dot position in the column. In this way a series of up to seven dots are printed at each of the five column positions for the character. The hammer is at a slight angle to the vertical and throughout this process it is continuously moving along the line, so that as the lowest dot is printed at the current column position, the top of the hammer is in the right position for the topmost of the next column of dots (see Fig. 1). The forming of dots by means of two narrow bars set at right angles, one on each side of the paper, is responsible for the fact that the dots are less well defined than those produced by the individual needles of more expensive dot matrix machines. No indication of anticipated head life is given anywhere in the literature.

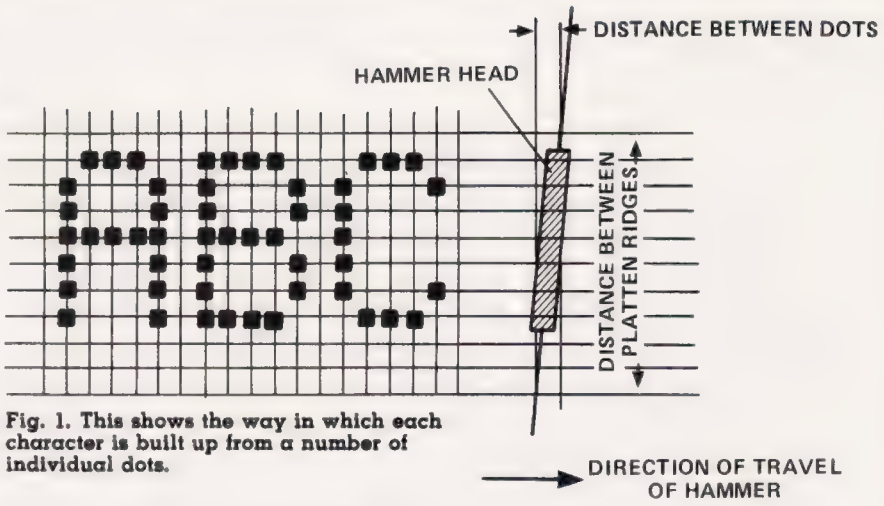


Fig. 1. This shows the way in which each character is built up from a number of individual dots.

The main disadvantage of this printer, apart from the typeface, is its speed: at 30 characters per second, it takes two or three minutes to fill a page, despite the fact that the print head doesn't travel all the way to the right hand side of a page after a line feed, as happens with some printers. As a result, it took me 11 minutes to produce five pages of disassembly of a machine code program! The noise level is also quite high, so you couldn't use it in the same room as someone wishing to listen to the radio or watch television. The fact that the ribbon is held close to the paper occasionally caused it to leave marks, especially where there was a slight ripple. This may be due in part to the new ribbon being full of ink and the effect may wear off as the ribbon gets older.

The printer has only two controls; namely a manual paper advance and an input selector switch. The latter has three positions: parallel; seven-bit serial; and eight-bit serial. It will accept a number of software format controls such as Carriage Return with or without Line Feed and Tab (by character or dot position), it will not, however, accept Form Feed. Double width character and graphics modes are also controlled by software. In the graphics mode the number of lines per inch increases from six to nine, to eliminate gaps between the lines in order to give continuous coverage of the paper. The graphics mode is somewhat cumbersome to use as each dot is controlled individually by regarding the column dot positions as binary numbers, the most significant bit indicating graphics mode, and the other seven representing the seven dots. Consequently, if you wish to produce a graph or a picture, you have to sit down and work out which dots you need to print, and convert the result to decimal (or Hex if you're using machine code), to send to the printer. This could be somewhat laborious, as each line contains 480 x 7 (ie 3360) dots! However, I don't doubt that someone will soon produce the software to facilitate the simple exploitation of the graphics capabilities. Indeed, one advantage of the massive user base of the TRS-80 is that, no matter what you want to do, someone has probably already done it and will sell you the necessary software. This is the case particularly in the US where there are several magazines, some averaging over 300 pages a month, devoted entirely to the TRS-80.

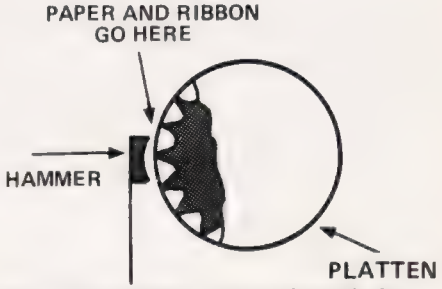


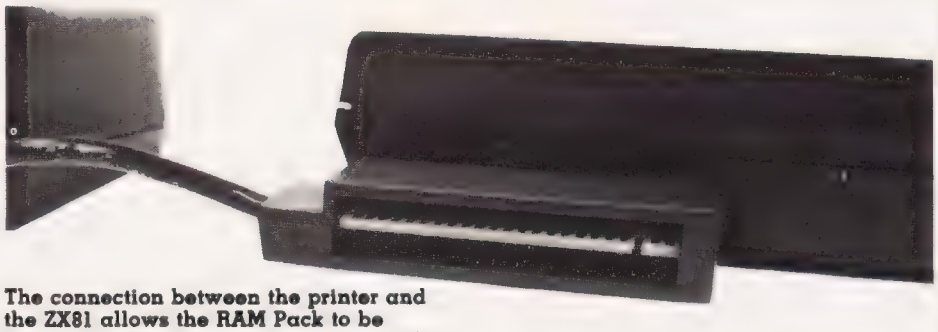
Fig. 2. The hammer strikes through the paper and ribbon and the point is formed by the hammer head hitting one of the ridges on the platten.

Conclusion

Apart from the drawbacks of speed and noise, the Tandy Personal Line Printer represents good value for money. If you are looking for cheap hard copy, and can live with the output, then this printer should feature high on your shortlist. Tandy seem, in this instance, to have got the price right and to have produced the right product at the right time.

Peter Freebrey

The ZX Printer has been around now for a few weeks and has been seen at exhibitions and demonstrations on numerous occasions. It is still a pleasant surprise to handle and to use, as it is very compact and has that weighty feeling normally associated with functional and robust equipment. It comes complete with the uprated power supply (1.2 Amp) necessary for use with the ZX81 (or a ZX80 with the replacement ROM) and one roll of printing paper. The ZX Printer uses its own special metallised paper as supplied by Sinclair Research and this costs £11.95 for five rolls. Each roll is 65 ft long, and should enable you to print about 6500 lines of print or about 260 screenfuls of information! Other metallised paper may well work — if you can find a roll which will fit; but not surprisingly Sinclair suggest that their paper will give superior results. The ZX Printer and 1.2 Amp power supply arrive well packaged in expanded polystyrene to enable the Post Office to play rugby with it and yet still arrive on your doorstep in perfect condition.



The connection between the printer and the ZX81 allows the RAM Pack to be attached at the same time, as seen in the picture at the foot of this page.

Putting It To Use

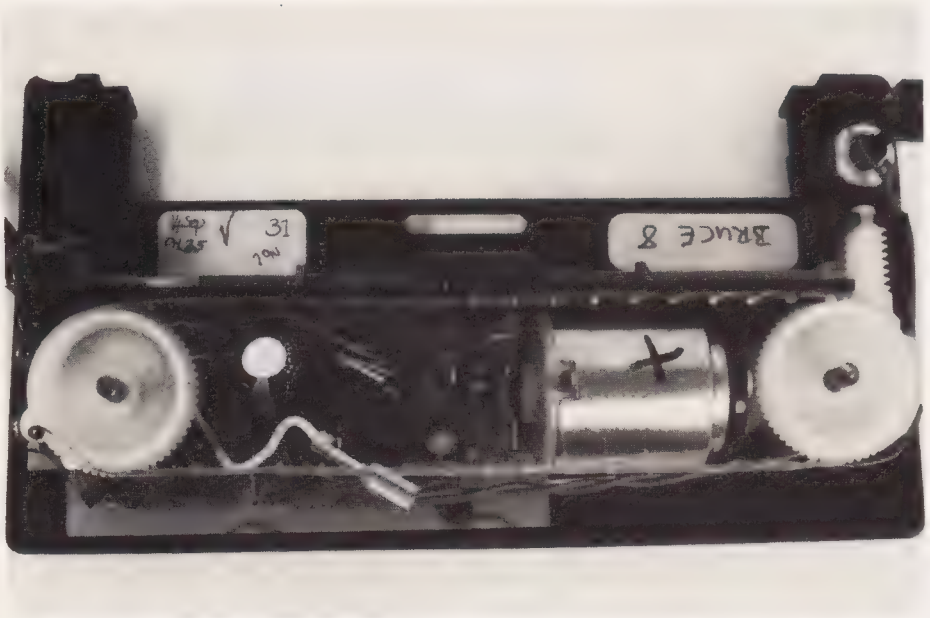
The ZX Printer is extremely simple and quick to put into operation. It takes longer to put a mains plug on the power supply lead than it takes to plug in the printer and learn the use of the one control available — the paper feed. The plug on the printer lead has an integral socket to accept the add-on 16K RAM pack. The 17-page instruction book gives a clear description of how to load a fresh roll of paper, use of the feed button, tear the paper neatly off the roll (!), clean the printer and, of course, the general principle of operation. There is also a selection of programs aimed at giving you the pleasure of seeing your new aquisition work, while at the same time showing the use of those BASIC statements associated with the ZX Printer. Strange as it may seem, these BASIC statements are neither explained nor described in the text; instead we are directed to read chapter 20 of the ZX81 instruction book.

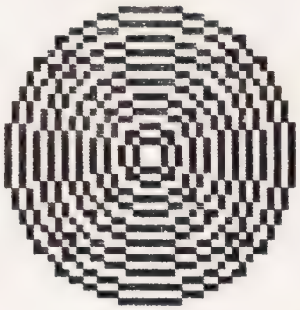
It would amuse me to report that the ZX81 instruction book then referred you to the ZX Printer instructions, it does tell you that the printer will have instructions with it, but nonetheless continues with a short chapter to quite clearly explain the function of the three relevant BASIC statements. These are LLIST, LPRINT and COPY. The first two are just like LIST and PRINT except that they direct the display to the printer instead of to the television screen or monitor. The third statement, COPY, enables you to print out a copy of whatever is displayed on the screen at the time.

General Theory Of Operation

Normally when reviewing equipment or books it is not the 'done thing' to quote more than a sentence or two from any supplied text but in this instance the ZX Printer instruction book gives us a very simple and concise description of the basic workings of the printer . . . .

'the printer functions in rather the same way as a TV picture, ie by scanning from left to right. A conductive stylus is pulled across the paper at high speed, and where a black dot is wanted a pulse of current is passed through the stylus. This evaporates the aluminium coating on the paper, and allows the black backing to show through. To avoid the need to return the stylus quickly to the left-hand edge of the paper, there are in fact two styli, mounted on a moving belt, which follow each other in quick succession. The belt and the paper feed roller are both driven continuously whilst printing; so that when the next stylus comes round, the paper has been moved up ready for the next line.'

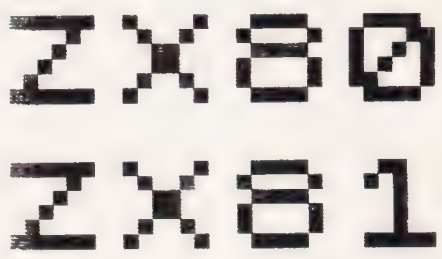




The internal workings of the printer. The belt carrying the two styli runs between the two white pulleys. Some examples of the printout are shown on the left.

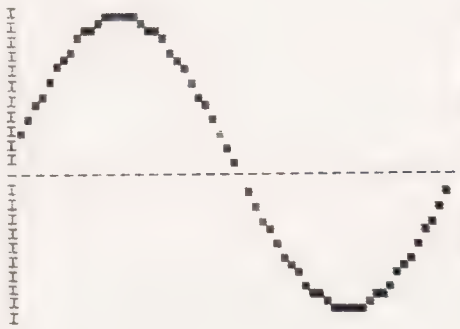
Having only three major print statements to consider, the ZX Printer is very easy to use. Formatting the display to the printer can be carried out using the TAB and AT (@) statements, albeit when using the AT statement line commands are ignored and only column commands in the range ±21 actioned. Although unlikely to cause much confusion, it must be remembered that the output from LPRINT is not printed immediately but stored in a buffer one line long. The computer will only print:

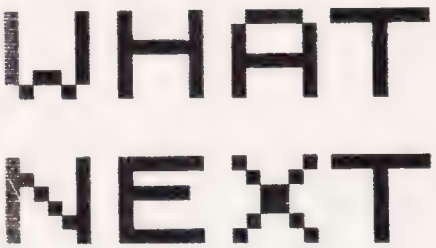
1) when the buffer is full
2) after an LPRINT statement that does not end in a comma or semicolon
3) when a comma or TAB item requires a new line
4) at the end of a program if there is anything left unprinted.

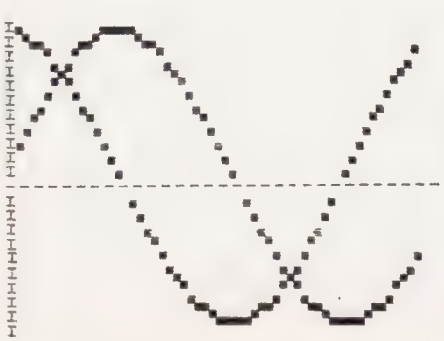


In Conclusion

The printout presented by the ZX Printer was clear and readable with no disturbing fuzziness which occasionally has been seen with other systems. Graphic symbols can 'join up' from line to line giving a clear continuous picture. Keeping the printer clean is probably very important and although the review model has been tested to some extent, long term reliability can only be commented upon at a later date. As with the ZX81 and the ZX80 before it, the ZX Printer offers something that, for the initial outlay, is quite remarkable and can only add to the effectiveness of your ZX system.







```
ZX81 ▓▓▓▓ ZX81 ▓▓▓▓

5530 CLS
5540 PRINT "AND FINALLY, THE PRI
NTER CAN BE USED TO PRINT TEXT"
5550 FOR N=1 TO 100
5560 NEXT N
5570 LPRINT "ZX81 ▓▓▓▓ ZX81 ▓▓▓▓
5571 LPRINT
5572 LPRINT
5573 FOR N=0 TO 50
5577 NEXT N
5580 PRINT ,,"AND LIST PROGRAMS"
5590 FOR N=0 TO 40
5600 NEXT N
5610 LLIST 5530
5620 LPRINT
5630 LPRINT
5640 LPRINT
5650 LPRINT
5660 PRINT "FOR ANOTHER CYCLE"
5670 GOTO 1142
```

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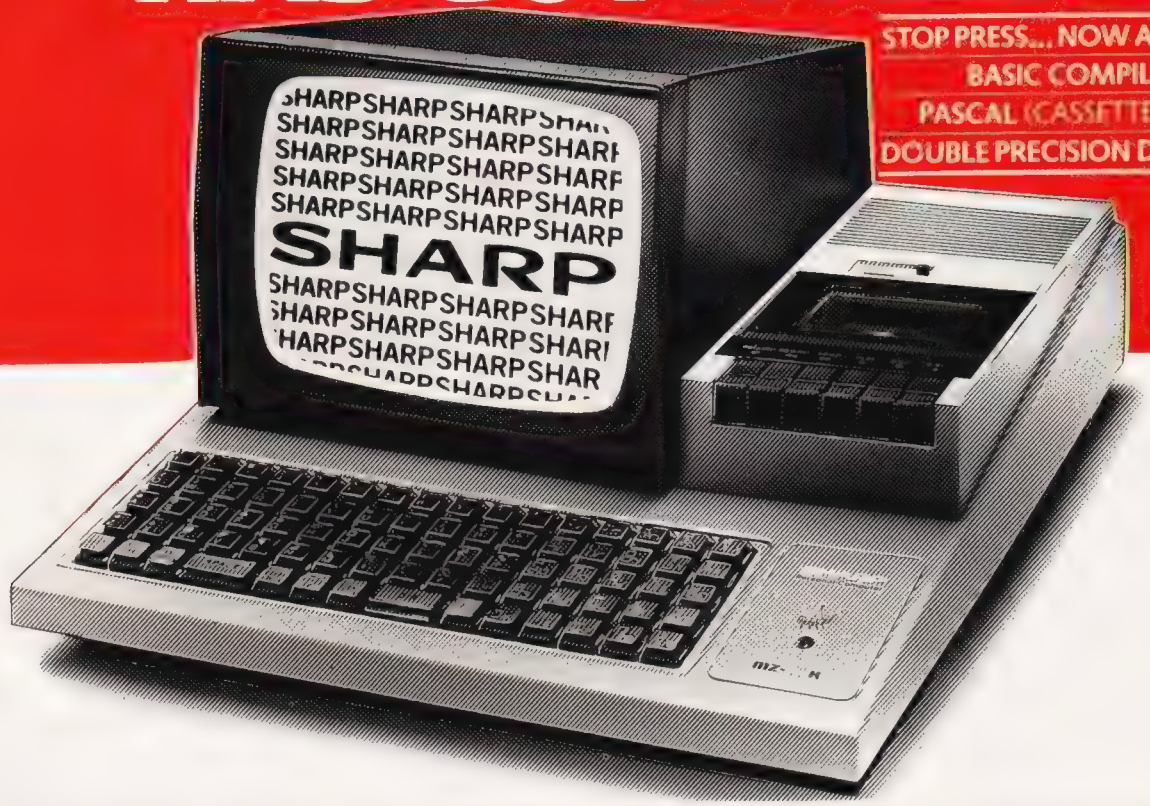

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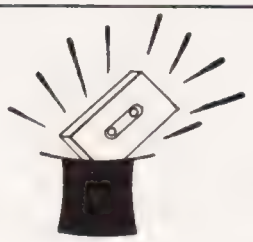

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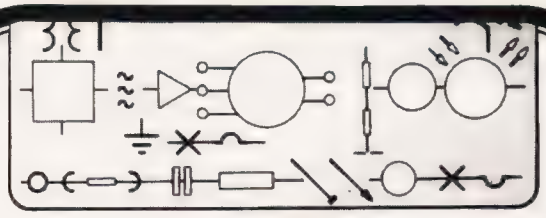

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Rex Malik

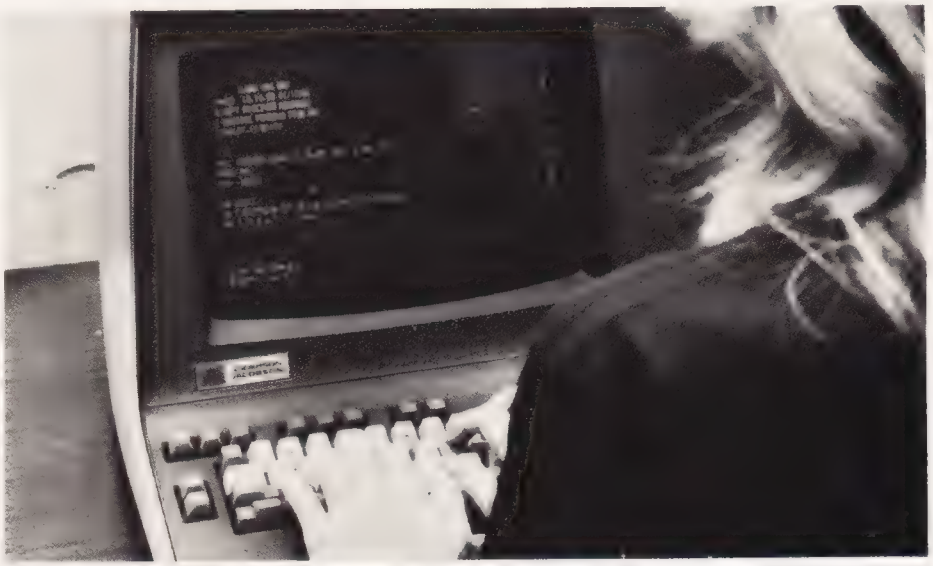
THE INFORMATION AGE

Following fast on the heels of our articles on Teletext and Viewdata, Rex Malik takes a stroll through the portals of The Year Of Information Technology to show us what's likely to happen in the coming decade.

Three cheers — or should it be two and a half — for the coming of the information society. Welcome to the all singing, all dancing, real time, fully interactive, brightly coloured, all electronic, home centred information era.

That is how a circus barker would have put it if he had been listening to some of the more interesting gurus and prophets who abound in the fields of technology, computing and telecommunications these days. But it is all hokum, or is it for real? Is there really something new going on out there or is it just another fad like hula hoops, skateboards or Space Invaders?

It is for real. All the investment money being poured into it says so. That money comes from Governments and big corporations — it is banking money.



I P Sharp's Mailbox service in operation.

The Effect On You

But what has all this got to do with the readers of Computing Today? Well by definition you will be a computer buff, indeed a lot of you will be full time 'hackers'. Although you may not agree as you try to patch your BASIC program and 'Syntax Error' comes up for the 23rd time, you are part of the vanguard. The role you play in the coming era is going to be very similar to that played by the wireless buffs in the Twenties and with the same sort of effects as they had on the growth of amateur radio.

My brief, the Editor said, is to discuss (without getting too technical about it) some of the products and systems of the coming era — say over the next 10 years — and to discuss some of the likely changes that could occur and their possible impact on our everyday lives.

I must mention here that changes affecting our everyday lives are the most difficult to predict. The trouble is that there are two different processes at work in this area. One is a set of substitution processes, the other is a set of new processes — by this I mean new human experiences — which could never have been previously experienced no matter how unlimited the resources. Just to cloud the issue further it is often difficult to tell where one process ends and the other begins. Let us first look at a couple of examples of substitution.

Substitution In Operation

Using Prestel's Viewdata technology at home one can access, say, a British Rail timetable. You have just substituted electronic print for traditional print, assuming of course that you had the printed volume. You have also substituted one electronic means for another. The likelihood was that you didn't have the printed timetable and would have had to rely on a 'phone call instead. That 'phone call would have been limited — I cannot see either you or the enquiry service running through all the possible alternatives!

Prestel, however, gives you the widest set of options and, what's more, is up to date — indeed you would soon stop using it if it wasn't. The simple example of substitution has become rather complicated.

Let us try another example, still using Prestel. Prestel users can now send messages to one another in such a way that when you switch on your receiver the system will alert you to the fact that a message is waiting for you. The system is currently limited for most users; only those with a full alphanumeric keyboard can enter free form messages, the rest of us have to be content with a set of standard formats.

Nevertheless, we can safely say that sometime in the next two years sets will become available equipped to use the electronic mail facility in its true sense and those sets will have to have an alphanumeric keyboard, thus giving the mass market an electronic mail facility. Whether the mass market takes to it is a function of its cost and the availability of suitable Prestel sets. The majority of television receivers are still supplied by rental companies, over 50% in fact, and these are expected to have a reasonably long life — after all, the rental companies want to recover their costs — so we can hardly expect the change-over to be swift and dramatic.

What is the substitution that takes place here? Well, it is obvious that substitution for the telegram occurs, as well as a substitution for some telephone messages, since we are not dependant on the subscriber we are calling being available — the computer will hold the message for us. The system also substitutes for the Telex service, but at the moment only for the inland service.

The obvious substitution is that of the postal service; why else call it electronic mail? But the sytem does not substitute for ***all*** mail, it can only substitute for the letter post. Long items, parcels, papers etc will still have to come through the conventional postal system unless users proceed to buy storage devices and printers — a disc drive in every home?

Come on, the notion is absurd. But, why should it be? Technological change is going to continue and the extra storage needed may well come built into the set itself, as might the printer.

Neither idea is fanciful, there are Viewdata sets already being developed which have built-in printers and if you want one now you can always buy a stand-alone printer from someone like Advanced Consumer Electronics who will willingly supply you with one for about £130.

As for storage, I have seen one company's plans to incorporate a tape deck so that users can pull down information, thus saving themselves the telephone charges if they want to view it more than once.

The Internal Option

But, why should one assume that tapes and/or other moving magnetic media are the way out? They may represent the economic solution ***now*** but they could well be superseded for small amounts of storage. There is, after all, some IC based storage already in the Prestel terminal, there could soon be a lot more.

For example, the Japanese implementation of Viewdata is called CAPTAINS. This is slightly different to the Prestel system in that the character generator required to drive the terminal is actually the system's central computer. This is because the Japanese alphabet (if you can call it that), has thousands of characters — many of which are complex ideograms (word pictures). To hold all these in the terminal would require substantial amounts of memory which, when the system was designed, was quite expensive.

But the present method of operation creates some problems, the most important of these being the time delays involved in accessing data. How are they solving it? Well, bit by bit ***(Do puns come worse than this? Ed)*** storage is being moved into the terminal. Indeed, Hitachi had an experimental terminal on show at the recent Viewdata '81 conference held in London which used local storage. Fujitsu are also developing a system called DAVINS in which the set has all the memory required as well as a lot more local intelligence.

The point is that cheap semiconductor storage is now with us and beginning to move in: I'm not talking in terms of 4K segments, more like 256K and up. So, while the notion of separate moving media devices and printers may seem absurd (apart from anything else where would you put them in the living room), the notion of a technological offering which fulfills the same function is not.

It will have become apparent that, in considering these two types of use for Prestel/Viewdata, information retrieval and electronic mail, one can agree that substitution does happen but something more is going on.

An Alternative Approach

This takes me to the second set of processes. I can best illustrate the direction in which I am heading by considering another version of electronic mail which also uses the telecommunications network but does so ***internationally*** and has been in operation for over 10 years.

Currently connecting more than 300 terminals in 60 offices spread over 20 countries, I P Sharp's MAILBOX service is this network. Their UK Managing Director, Fred Perkins, recently spoke at the Online Business Telecoms Conference and, among other things, said this:

> "Electronic mail is a totally new medium of communication, the like of which the world has not seen before. To judge it as an alternative to the telephone or Telex or carrier pigeon is to miss the point".

He then went on to point out that it is true that aspects of electronic mail do offer viable substitutes for conventional methods of communication — the substitution discussed above — but its real strength lies in its ability to provide its users with all the information they need about anything within their sphere of responsibility or operations.

It might be useful to describe the system in slightly more detail. The operation is run by I P Sharp (perhaps better known for their APL software) from a computer centre in Toronto and is accessed through leased lines and a number of packet switched networks — some of them international.

The service offers two types of address — the individual and the group — with the latter being either permanent or transient. This means that the geographical location of any individual, or group member, becomes irrelevant provided he or she has access to a terminal. Furthermore the system uses English language commands, so a knowledge of programming is not required and it can even be linked into the organiser's computer.

It is obvious that MAILBOX is not just an electronic version of the existing mail/message systems. It fulfills these functions but it is also highly interactive. The group broadcast facility referred to earlier is, therefore, more than just a message service; it allows meetings to be called and opinions to be gathered.

So, in this mode, is it an electronic version of a committee meeting? In one sense obviously 'Yes', but in another equally 'No'. 'No' because it is largely time independant. Fred Perkins put it this way "...pseudo meetings are event oriented rather than time oriented". And, because of this, everybody gets a chance to have a say and everybody else has a chance to see it.

What has just been described is something which has substitution effects, but they are not simple. As the above has shown, there is mail, telephone and telex substitution going on here as well as the substitution for face-to-face meetings, whether singular or group, formal or informal. What we are discussing, therefore, is the birth of a new medium. It is true that it has substitution characteristics, all the systems we have touched on have those, even MAILBOX has its roots in trying to do old things in new ways.

The New Growth

But, they all add something new. Can we isolate what that new thing is? Well, some professionals have had it for years, as in the MAILBOX example, others may have found it in their business systems.

We can call it the capability to interact with a complex information environment in real time, the production of mass market systems which are relatively cheap and user friendly. What these are going to do to society nobody knows, though one can forsee some of the likely effects in a number of areas. Indeed, trying to grapple with the technology and its effects is where I have been spending increasingly more of my research and writing time.

Let me explain why it is so difficult to work out what could happen by looking at a piece of technological history. This gives only a guide to the possible magnitude of effect not of the effect itself.

The piece of history is concerned with the growth of the railway industry. At one level you can look at this as the substitution of trains for horse-drawn carriages, waggons, barges, horses themselves and even feet. At another level you could look

at it as the bringing together of three well known areas of technology; the track, the wheel and the steam engine.

These viewpoints only take you so far. Where they do not take you (and society had to wait until trains existed in large numbers for it to become obvious) is in the direction of being able to forecast social change. You can forecast a ***substitution*** but this is only part of the picture.

Thus you could predict, as some people did, that the train would sound the death knell for the canals, at least for commercial, large — scale transportation purposes. But, how could you predict the pace at which the integration of the train changed the growth of the cities, which it did? And, how could you forecast its impact on the growth of the suburbs, indeed how it made these possible? Prediction, in these terms, means to put a time span on the event which is shorter and more realistic than saying 'within the next century'.

How, indeed, could you have predicted that the two contrary trends above, drawing people into a city for their work and making them leave it to live elsewhere, could have brought about a whole new industry based on gardening?

How, also, could you have foreseen the impact the railways had on creating a national distribution system when this was unknown, or the consequent (some time later) creation of an advertising industry and a national newspaper industry?

Trains changed life as it was known and did so in a drastic way. But, the processes involved took a long time to occur. There were first, second, third and however many other orders of effects you care to think of, some of which are still being felt today.

If you want to get closer to the present day, how could you forecast the effect and impact of television in a society which does not have it? Well, you start by thinking of substitution, which is what the film industry did. It refused to have anything to do with the new medium, guessing (rightly) that it would be a substitute for the cinema. The fact remains that, even allowing for the increase in population between the fifties and the present day, there has been a massive increase in the output of film material worldwide. This would not have happened if we had been stuck with the distribution methods that relied on the cinema as the main outlet.

You may well say at this stage that I am making things difficult. I am, because the subject is! Indeed, some of the best minds on the planet are busy trying to understand what is going on out there and what it all means. And, I may say, with surprisingly little success — though perhaps if you think about the two examples above, that lack of success will not seem so surprising.

One of the four prototype Annuaire Electronique terminals.

Taking the Medium Apart

Let us try to go back to the new medium and get some understanding of its component parts. What we can say about it for a start is that it has a generality. Indeed, it cuts right across the famous hot and cool definitions of Marshall McLuhan. It is obvious that it is not a broadcast medium, yet there are times when it encompasses it. For instance you can take a broadcast output and work with it. That output will be used to trigger off some other activity. Let me give you two possible examples.

Imagine that there is a current affairs programme being shown on television which is being watched by a number of people. Argument starts, as argument often does. You could, in theory at least, reach for Prestel to obtain the latest background facts. In most cases you can't actually do this now because Prestel is currently short of encyclopaedic information and the sets are not organised to superimpose one set of information on another. This facility does exist on the Teletext system however, so it may not be long before the same is possible on Prestel.

This facility is actually exploited in my second example which is a closed, Viewdata-type system called TOPIC. The system is run by the London Stock Exchange and is an information facility for the stock market of the type known as a Closed User Group (CUG for short). On these systems the information is only available to a closed group of people — in this case stockbrokers and their clients.

TOPIC has an interesting facility. When you are accessing information on that system, whether in a CUG or on the general data base, there are a couple of lines free at the bottom of the frame. These are reserved for news flashes or information of

general interest to the wider group, all TOPIC users. So whatever you may be dealing with or looking at, you can be kept in touch with events set in the wider context of the stock market and the events that have an impact upon it generally.

What else is the new medium? It is obvious that it is not confined to the Viewdata technology, though the principles of both are similar. These principles are that, by the use of digital telecommunications and mass market (ie easy to use) terminals, one should be able to access information and work with it.

It is obvious that it is combinatory; it calls on telecommunications, graphics, print and computing technologies and, no doubt before the decade is out, it will combine video too.

Future Hardware And Services

Let us harden the ideas up. What could a home user access before the eighties are out? I am not going to say that the home user will have all the facilities I am about to list or all the services, all I am doing is to bring together the various systems currently under development.

For a start they will have equipment which is available now. It may well be that many people will be content with one TV set which has some local intelligence and is capable of being used for Prestel, Teletext and the usual TV broadcasts. This set could also be used for electronic mail and, because it has an alphanumeric keyboard, it could also cope with some of the transaction processing functions I'll describe in a minute.

I write, 'It may well be . . .'. Somehow I doubt that people will be happy to do all this on one terminal, I suspect that they will need at least two with the capabilities spread between them. The reason I doubt that it will all be done on the one terminal is that experiments have already shown that the medium is very powerful, it destroys all other activity while it is in use. This means that you may not be able to keep it in the living room — if you have a micro, think of how and where you use it.

The power of the medium has been investigated. I was at Bell Northern Research in Ottawa earlier this year and they were telling me about some market research they had done with the Canadian version of Prestel.

A small bit of this is worth retelling. They described the system to eight little old ladies, people who had no understanding of any technology. Six of them had immediately responded that if the medium made demands, required privacy in other words, then they would have to give up the spare bedroom to it.

I mentioned earlier that the purpose of the medium was to allow the user to obtain information and process it. In the home context this processing could take the form of an Electronic Fund Transfer. This could be a process such as ordering wine from the wine club, books from the book club, airline tickets, holidays or even EFT proper — the access of one's own bank account and its debiting in favour of someone else. In other words, electronic banking.

You may have heard of that before. As a possibility it has existed for a number of years and often shows up in future scenarios. Did you know, however, that it already exists in West Germany. Admittedly it has not been going on for very long but already one bank has some 2000 electronic customers, people it rarely sees. And, interestingly enough, there is a usage pattern developing already. The bank's customers tend to use the system in their own time; it runs 24 hours a day, and usually when the banks are not normally open. Peak traffic is when the evening's television programmes have finished but if there is a poor viewing evening the traffic tends to start sooner.

If you take the route of having two terminals, it is likely that one will be a modified TV and the other will be micro based. Indeed, the printer I mentioned earlier may be replaced by a facsimile transceiver which doubles as a printer. If you think that this is fanciful then you're wrong. In France there is one under development, I have played with the development model, which is scheduled to arrive next year and will cost less than £200. The French telecommunications authority may well rent them just as it rents the telephones.

With a device such as this you can transmit written or pictorial material and, because it was designed to work with their Viewdata system, it doubles as a printer for that as well.

Also under development in France is the Annuaire Electronique, the on-line telephone directory. It is their aim to have the whole of the French telephone directory available electronically and accessible via a local call.

You may wonder who's going to pay for this device. The answer is nobody, they are going to give them away! They calculate that by installing some 30 million terminals over the next 10 years the cost will come down to about £50 each at which price they simply become part of the service. They will also save on all the printed volumes and most of the staff required to man the existing service.

This same terminal could be used to do other things such as those mentioned above and the French are currently researching how the terminals can be designed to be used by anyone. Even with all this research it is unlikely that a totally foolproof system can be produced at a reasonable cost so one is still likely to find a 'panic button' which will summon a human operator to your aid.

In Conclusion

What I have tried to do has been to guide you through some of the possibilities for the next decade and to give some indications of the new electronic environment. I have concentrated on systems which exist, which are in some way commercial and have already come out of the development laboratory.

What I have tried to show too is that this raises all sorts of possibilities, and that history shows that when you get a set of developments of this order there is consequent social change. I have very carefully avoided what that change could or might be.

I have not investigated it because it is difficult to forecast and it is difficult because the new medium is not so much one, or even a set of, products but forms an environment. The changes that one could predict are major but they could also be complex.

My own views on what these changes could be and might be would take up the space of a book. Indeed, they will, I am currently writing it!

In that book I go further, much further. I will, however, leave you with one thought that is central to this book. It is that the technology I have just described is approaching the stage which, in the motor car industry was known as that of the Model T Ford.

We are at the beginning of a mass market, interactive, electronic era. Coming up is the slicker motoring of the present day with its variety of devices aimed at different markets: the second hand and the 2CV compared to the Porsche and the Rolls.

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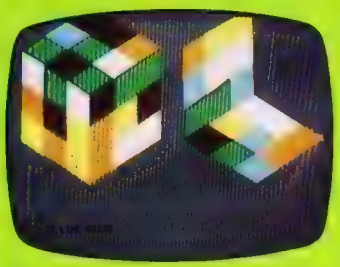

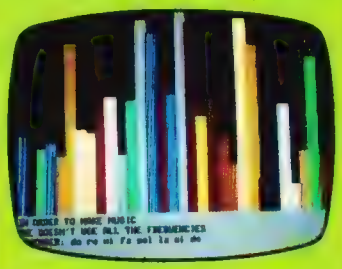

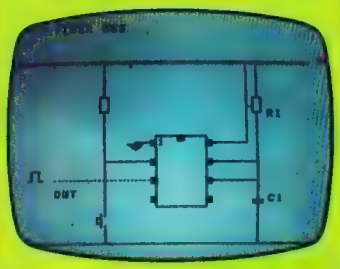

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74C74	59p
74C76	57p
74C85	134p
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8226	250p
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2 0MHz	250p
2 45760MHz	250p
3 276MHz	250p
3 5795MHz	175p
4 00MHz	290p
4 194MHz	250p
4 43MHz	125p
6 0MHz	250p
6 144MHz	250p
7 0MHz	250p
7 168MHz	250p
8 00MHz	250p
8 86MHz	250p
10 00MHz	250p
10 7MHz	250p
15 0MHz	350p
16 00MHz	250p
18 00MHz	250p
18 423MHz	250p
19 ·68MHz	390p
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75115	160p
75150P	140p
75154	140p
75182	230p
75324	375p
75361	150p
75363	150p
75365	150p
75451/2	72p
75453/4	72p
75491/2	70p
8126	120p
8128	140p
8195	140p
8197	140p
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81LS96	120p
81LS97	90p
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(as described in "P.C.W." Oct. '81)

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5A12v	600p	−5A TO3		650p

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Andrew Thomas and Gareth Callister

If you thought that fantasy games were illogical then this easily expanded or adapted program should make you change your mind.

If you're fed up with the type of adventure that's entirely random and involves no real skill, here is a game which is truly logical.

Like all good adventure games your task is to recover the magic chalice which has been stolen by an evil sorcerer who is hiding in the labyrinth of the White Barrows. This labyrinth is arranged in a stable pattern (see Fig. 1.) and each of the chambers has an identifying number. The sorcerer is powerless to escape from the labyrinth while carrying the chalice but if you trap him he will drop it and promptly disappear. To aid you in your task you are equipped with a magic staff and a limited supply of magic.

The Nasties

Lurking in the labyrinth are dragons, serpents, dwarfs, goblins and magic spots. These remain in their own chamber in the labyrinth, they cannot move around like the sorcerer. The program will issue warnings as to the content of the chamber you are about to enter, but these are not in any particular sequence. You may receive a warning about a serpent while you are in, for example, chamber 2 but you will not know — unless you can remember — in which of the four possible move positions it is. You can use the ***View*** command to check the chamber but this will use some of your limited stocks of magic.

If you are unfortunate enough to run into a dragon, serpent or dwarf you are faced with one of three choices:

You can ***Stun*** it, but you must leave the chamber immediately or it will recover and attack you.
You can ***Transport*** it, but if you are really unlucky it may reappear in the same chamber.
You can ***Destroy*** it, in which case the creature is removed from the game.

All the above options use some of your magic, the actual amount depends on the creature type and which of the options you choose; these are listed in ascending order of magic required. If you do not use sufficient magic the creature may be stunned (in which case you get a second chance) or it may just get angry and attack you.

The goblins are actually on your side — but for a price. They will tell you where the sorcerer is hiding provided you supply them with gold coins. You can make these with your magical ability but don't be too hasty, as the system gives the same warning for a goblin approaching as for the friendly gnome who doesn't need bribing.

There is one further obstacle hidden in the labyrinth — a magic spot. This, if trodden on, will instantly transport you to another location within the barrow. Murphy's law determines that no matter what peril you were in before you were transported, the situation you find yourself in will be ten times worse!

The Sorcerer's Habits

The evil sorcerer does have a degree of intelligence. If you walk into the chamber in which he is hiding, he will run off. The distance he will run can be up to three chambers and, if he can find it, he will always tread on the magic spot to further confuse the issue. To retrieve the chalice you must trap him. This is not easy (the game wouldn't be much fun if it was) but there are three aids for your task:

The sorcerer will not move to a chamber that you have just left.
He will not enter a chamber that contains a goblin.
He will not enter a chamber in which you have created the magic wall.

This magic wall can be created at any point in the labyrinth but only one wall can be created at any one time. If you build a second wall, the first will fall down! You cannot build a wall in a chamber which is already occupied — if you try, it will fall down straight away.

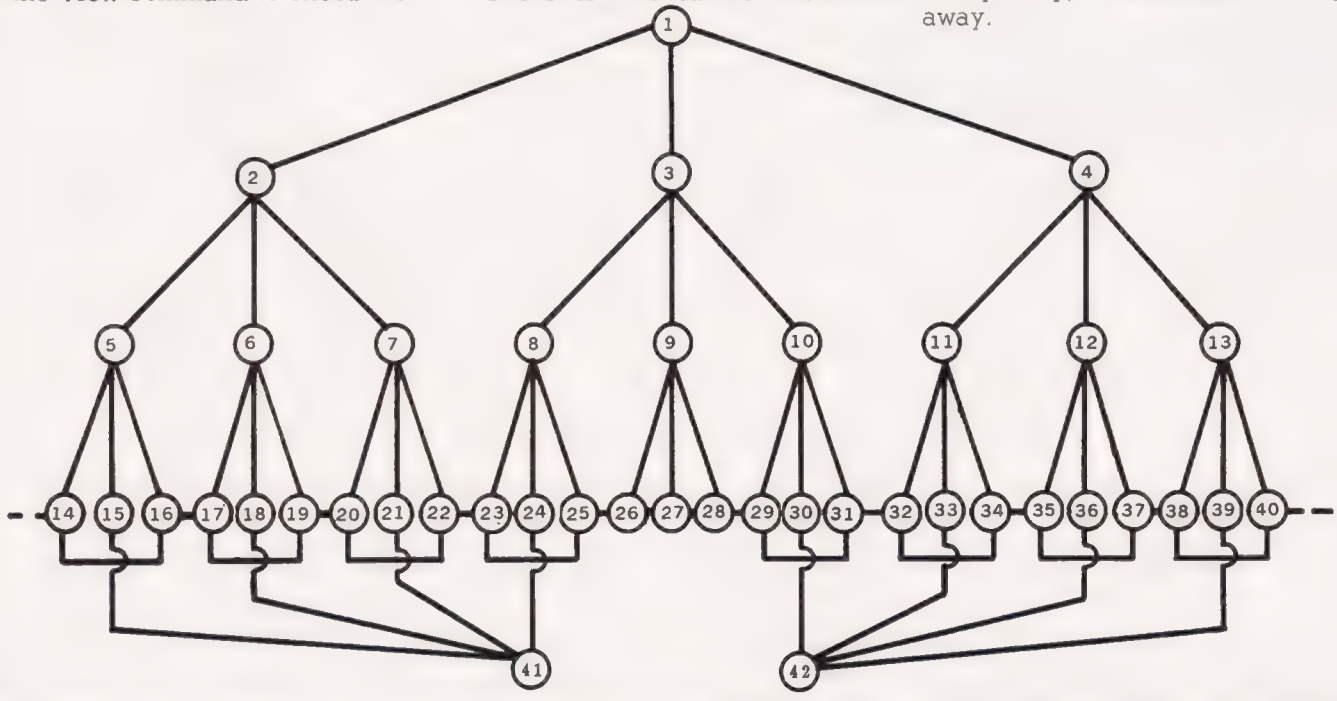


Fig. 1 The map of the chambers and their interconnections found inside the White Barrows. The map is stored in the string array $A.

THE WHITE BARROWS

The final option available when all else has failed (you've run out of magic or been killed) is the possibility of re-incarnation.

The Program

The original code was written for an Acorn ATOM with the full 5K installed in the lower text area. It should prove possible to adapt the program to run on other systems and some notes for this are given below.

For those intending to load the program into an ATOM, it will be necessary to use the abbreviated form of the BASIC commands and to remove some of the spaces which have been included for legibility. Note also that the normally unused 512 bytes in the upper text area have been reserved for string storage.

Conversion Notes

The string handling commands on the ATOM are, to say the least, unique. However, in this program they have been used in such a way as to make their conversion as simple as possible.

The first major conversion starts by finding all the lines where strings are used. The ATOM labels its string variables with the $ first, $A for example. All these must be transposed to come the correct way round.

While on the subject of strings the following batch of lines needs altering:

```
9000  A$="......
9010  A$=A$+"....
9020  A$=A$+"....
9030  A$=A$+"....

3090  T=ASC(MID$(A$,C*4-4+I,
      1))-48
6020  BB(I)=ASC(MID$(A$,
      Y*4-4+I,1))-48

 200  IF LEFT$(Q$,1)="V"
      THEN GOSUB 5000:GOTO 240
```

The PRINT statement on the ATOM is configured so that those ending with a ' act as a normal PRINT. If there is no ' at the end of the line then you need to add a ; and if there is more than one ' you will need an extra PRINT for each extra '.

The random number generator gives both positive and negative numbers, hence the ABS function. Replace line 4120 with:

```
4120  R=INT(RND(1)*20)+20
```

Other lines that need alteration are:

```
  20  DIM AA(N),BB(3)
2000  ON AA(Z) GOTO 2010,
      2020,2030,2040,2050,
      2060,2070,2080,2090
6090  R=INT(RND(1)*4)+1:IF
      MID$(Q$,R,1)="[SPC]"
      THEN 6090
6100  Q$=LEFT$(Q$,R-1)+"[SPC]"+
      RIGHT$(Q$,4-R):T=AA
      (BB(R))
6200  F=0:Q$="1234"
```

And, finally ATOM multi-statement delimiters are represented by ; and these should be changed to the more usual : . The program should now run under most BASICs. Oh, the $12 is a Clear Screen and the $8 is a Back Space.

Variables

For those interested in the structure of the program the following variable list may be of some help.

$A	The string holding the sequence of chambers
B	Flag/random for attack
C	The chalice/sorcerer's chamber number
F	General flag
I & J	General loop count
K	Stun flag
L	Chamber where magic wall is
M	Amount of magic left in staff
N	Number of chambers
P	General numeric reply
$Q	General string reply
S	Strength of an object
T	Temporary store
U	Amount of magic used
W	Won flag
X	Contents of chamber
Y	Your chamber number
Z	Chamber number for object
Array AA	What is in the labyrinth
Array BB	All possible connections from a chamber

The structure is stored in $A and is constructed of blocks of four characters containing the connections from the chamber whose number corresponds to the block. Block 0 is a dummy. The chamber number is stored as an ASCII number + 48. For example, chamber 4 connects to 1;<= which, when translated, becomes chambers 1, 11, 12 and 13.

```
THE WHITE BARROWS


   YOUR MISSION IS TO TRAP THE
EVIL SORCERER AND RETURN THE
MAGIC CHALICE.
   YOU HAVE BEEN GIVEN A MAGIC
STAFF WITH 500 UNITS OF MAGIC.
USE IT TO OVERCOME THE
HAZARDS HIDDEN IN THE WHITE
BARROWS.  HIT RETURN TO
BEGIN.?

WARNING -

I CAN FEEL MAGIC VERY CLOSE !

TUNNELS LEAD TO 15, 18, 21, 24,
YOU ARE CURRENTLY IN CHAMBER 41
CREATE WALL, MOVE OR VIEW ?M

WHICH CHAMBER TO MOVE TO ?15
```

```
WARNING -
I CAN HEAR A DRAGON !

TUNNELS LEAD TO 5, 41,
YOU ARE CURRENTLY IN CHAMBER 15
CREATE WALL, MOVE OR VIEW ?V
WHICH CHAMBER DO YOU WISH TO
VIEW ?5

THERE IS A YELLOW DRAGON
IN CHAMBER 5.
YOU HAVE USED 19 UNITS.
YOU HAVE 481 UNITS REMAINING.

WARNING -

I CAN HEAR A DRAGON !

TUNNELS LEAD TO 5, 41,
YOU ARE CURRENTLY IN CHAMBER 15
CREATE WALL, MOVE OR VIEW ?M

WHICH CHAMBER TO MOVE TO ?5
```

```
YELLOW DRAGON
IS ABOUT TO ATTACK !
YOU HAVE THREE CHOICES:

1 - STUN IT.
2 - TRANSPORT IT.
3 - DESTROY IT.

YOUR CHOICE ?3
AMOUNT OF MAGIC ?50
YELLOW DRAGON
IS DAZED!

YOU HAVE USED 50 UNITS.
YOU HAVE 431 UNITS REMAINING.

THE YELLOW DRAGON
SUDDENLY ATTACKED !

OH DEAR, YOU APPEAR TO BE DEAD
WOULD YOU LIKE TO BE
REINCARNATED ?N
```

A typical sample of the game's output.

Program Listing

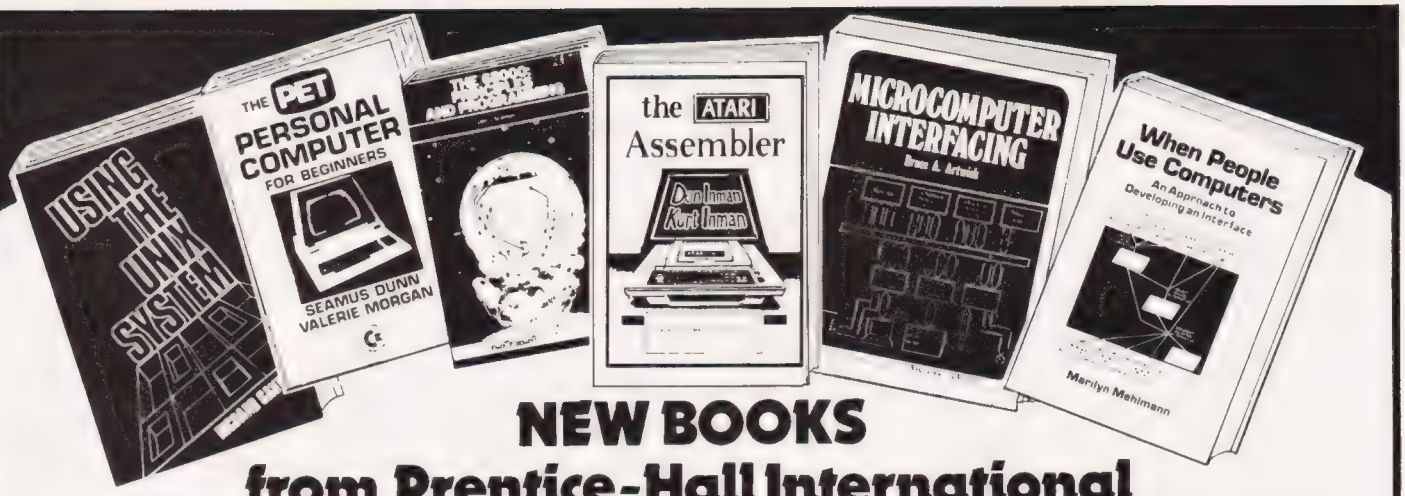
```
  1  REM**PLEASE READ TEXT FIRST!!!!!
 10  N=42;@=3
 20  DIM AA(N),BB(3);A=$8200;Q=$8300;
     REM**FOR $ READ A HEX ADDRESS
 30  PRINT$12"THE WHITE BARROWS"''
 40  GOSUB 10000
 50  GOSUB 9000
 60  GOSUB 8000
 70  FOR X=1 TO 9
 80  GOSUB 7000
 90  NEXT X
100  FOR I=1 TO 3
110  X=10;GOSUB 7000
120  X=11;GOSUB 7000
130  NEXT I
140  X=0;GOSUB 7000;Y=R
150  GOSUB 7000;C=R
160  M=500;L=0
170  W=0;K=0;GOSUB 6000
180  INPUT "CREATE WALL, MOVE OR VIEW "$Q
190  PRINT$12
200  IF ?Q=CH"V" GOSUB 5000;GOTO 240
210  IF ?Q=CH"C" GOSUB 4000;GOTO 240
220  IF ?Q=CH"M" GOSUB 3000;GOTO 240
230  GOTO 180
240  IF AA(Y)=0 OR K=1 OR AA(Y)=10 OR
     AA(Y)=11 GOTO 280
250  PRINT "THE ";Z=Y;GOSUB 2000
260  PRINT "SUDDENLY ATTACKED !"''
270  GOTO 390
280  IF M>0 GOTO 320
290  PRINT "YOUR STAFF IS NOW USELESS AND"'
300  PRINT "THE EVIL FORCE ATTACKS !"'
310  GOTO 390
320  IF W=0 GOTO 170
330  PRINT "CONGRATULATIONS YOU HAVE"'
340  PRINT "DEFEATED THE EVIL SORCERER !"'
350  PRINT "WOULD YOU LIKE TO TRAP ANOTHER"'
360  INPUT "SORCERER "$Q
370  IF ?Q=CH"Y" GOTO 30
380  GOTO 999
390  PRINT "OH DEAR, YOU APPEAR TO BE DEAD"'
400  PRINT "WOULD YOU LIKE TO BE"'
410  INPUT "REINCARNATED "$Q
420  IF ?Q=CH"N" GOTO 999
430  INPUT "THE SAME SORCERER "$Q
440  IF ?Q=CH"Y" GOTO 160
450  GOTO 30
999  END
1000 M=M-R
1010 PRINT "YOU HAVE USED "R" UNITS."'
1020 PRINT "YOU HAVE "M" UNITS REMAINING."''
1030 RETURN
2000 GOTO (2000+AA(Z)*10)
2010 PRINT "RED DRAGON"';S=30;RETURN
2020 PRINT "GREEN DRAGON"';S=25;RETURN
2030 PRINT "YELLOW DRAGON"';S=20;RETURN
2040 PRINT "PLATINUM SERPENT"';S=28;RETURN
2050 PRINT "GOLD SERPENT"';S=23;RETURN
2060 PRINT "SILVER SERPENT"';S=18;RETURN
2070 PRINT "DWARF WITH A SABRE"';S=24;RETURN
2080 PRINT "DWARF WITH A SWORD"';S=19;RETURN
2090 PRINT "DWARF WITH A KNIFE"';S=14;RETURN
2100 PRINT "FRIENDLY GNOME"';RETURN
2110 PRINT "MAGIC SPOT"';RETURN
3000 INPUT "WHICH CHAMBER TO MOVE TO "P
3010 F=0;PRINT'
3020 FOR I=0 TO 3
3030 IF BB(I)=P THEN F=1
3040 NEXT I
3050 IF P=0 OR F=0 GOSUB 6000;GOTO 3000
3060 IF C<>P GOTO 3180
3070 W=1;F=0
3080 FOR I=0 TO 3
3090 T=A?(C*4-4+I)-48
3100 IF T=0 OR T=Y OR AA(T)=10 OR T=L
     GOTO 3130
3110 IF W=1 OR RND<0 THEN C=T
3120 W=0;IF AA(T)=11 THEN F=1
3130 NEXT I
3140 IF W=1 THEN RETURN
3150 IF F=0 THEN PRINT "THE SORCERER HAS RUN
     OFF !"';GOTO 3180
3160 PRINT "THE SORCERER TROD ON THE MAGIC"'
3170 PRINT "SPOT !"';X=0;GOSUB 7000;C=R;
     GOTO 3060
3180 Y=P;IF AA(P)=0 THEN RETURN
3190 IF AA(P)<>11 THEN 3230
3200 PRINT "POWWW! YOU HAVE JUST TRODDEN
     ON"'
3210 PRINT "THE MAGIC SPOT!"''
3220 X=0;GOSUB 7000;Y=R;RETURN
3230 IF AA(P)<>10 GOTO 3300
3240 R=ABS(RND%20)+20
3250 PRINT "THE GOBLIN WILL TELL YOU WHERE"'
3260 PRINT "THE SORCERER IS FOR "R" GOLD"'
3270 INPUT "COINS. AGREED "$Q
3280 IF ?Q<>CH"Y" THEN RETURN
3290 PRINT "THE SORCERER IS IN CHAMBER "C
     "."';M=M-R;GOTO 3450
3300 K=0;Z=Y;GOSUB 2000;PRINT "IS ABOUT TO
     ATTACK !"'
3310 PRINT "YOU HAVE THREE CHOICES:"''
3320 PRINT "1 - STUN IT."'
3330 PRINT "2 - TRANSPORT IT."'
3340 PRINT "3 - DESTROY IT."''
3350 INPUT "YOUR CHOICE "P
3360 IF P<1 OR P>3 GOTO 3350
3370 INPUT "AMOUNT OF MAGIC "R
3380 IF R<0 OR R>M GOTO 3370
3390 PRINT$12;GOSUB 2000;PRINT "IS ";
     B=0
3400 IF P=1 AND R>S+RND%(S/3) THEN PRINT
     "STUNNED !"';K=1
3410 IF P<>2 OR R<S*2+RND%S GOTO 3430
3420 PRINT "TRANSPORTED"';X=AA(Y);AA(Y)=0;
     GOSUB 7000
3430 IF P=3 AND R>S*4+RND%S THEN PRINT
     "DESTROYED !"';AA(Y)=0
3440 IF K=0 AND AA(Y)<>0 THEN PRINT
     "DAZED !"';B=ABS(RND%8)
3450 GOSUB 1000;IF B>2 AND M>0 GOTO 3310
3460 RETURN
4000 PRINT "WHICH CHAMBER DO YOU WISH TO"'
4010 INPUT "CREATE THE MAGIC WALL IN "L
4020 PRINT'
4030 IF L<1 OR L>N GOSUB 6000;GOTO 4000
4040 IF AA(L)<>0 GOTO 4080
4050 PRINT "THE MAGIC WALL NOW EXISTS IN"'
4060 PRINT "CHAMBER "L
4070 GOTO 4110
4080 PRINT "ZAAPPPP ! CHAMBER "L" ALREADY"';
     L=0
4090 PRINT "CONTAINS MAGIC, THE WALL HAS"'
4100 PRINT "FAILED !"'
4110 PRINT'
4120 R=ABS(RND%20)+20
4130 GOSUB 1000
4140 RETURN
5000 PRINT "WHICH CHAMBER DO YOU WISH TO"'
5010 INPUT "VIEW "P
5020 F=0
5030 FOR I=0 TO 3
5040 IF P=BB(I) THEN F=1
5050 NEXT I
```

THE WHITE BARROWS

```
5060  IF P=0 OR F=0 GOTO 5040
5070  PRINT'
5080  IF P=C THEN PRINT "YOU HAVE FOUND THE
      SORCERER !"'
5090  IF AA(P)=0 THEN PRINT "THE CHAMBER IS
      EMPTY !"';GOTO 5130
5100  PRINT "THERE IS A "
5110  Z=P;GOSUB 2000
5120  PRINT "IN CHAMBER "P"."
5130  R=ABS(RND%20)+10
5140  GOSUB 1000
5150  RETURN
6000  F=0;$Q="1234"
6010  FOR I=0 TO 3
6020  BB(I)=A?(Y*4-4+I)-48
6030  F=F+AA(BB(I))-(100*(BB(I)=C))
6040  NEXT I
6050  IF F=0 GOTO 6170
6060  PRINT "WARNING -"''
6070  IF F<0 THEN PRINT "THE CHALICE
      IS NEAR !"'
6080  FOR I=0 TO 3
6090  R=ABS(RND%4);IF Q?R=32 GOTO 6090
6100  Q?R=32;T=AA(BB(R))
6110  IF T>0 AND T<4 THEN PRINT "I CAN HEAR
      A DRAGON !"'
6120  IF T>3 AND T<7 THEN PRINT "I CAN HEAR
      A SERPENT HISSING !"'
6130  IF T>6 AND T<11 THEN PRINT "I CAN HEAR
      MONEY RATTLING !"'
6140  IF T=11 THEN PRINT "I CAN FEEL MAGIC
      VERY CLOSE !"'
6150  NEXT I

6160  PRINT'
6170  PRINT "TUNNELS LEAD TO"
6180  FOR I=0 TO 3
6190  IF BB(I)>0 THEN PRINT BB(I)","
6200  NEXT I
6210  PRINT$8"[SPC]"'
6220  PRINT "YOU ARE CURRENTLY IN CHAMBER "Y
6230  RETURN
7000  R=ABS(RND%42)+1;IF AA(R)>0 GOTO 7000
7010  AA(R)=X
7020  RETURN
8000  FOR I=0 TO 42
8010  AA(I)=0
8020  NEXT I
8030  RETURN
9000  $A="23401567189:1;<=2>?@2ABC2DEF3GHI3JKL
      3MNO4PQR4STU"
9010  $A+LENA="4VWX5@X05Y005>A06@C06Y006AD07C
      F07Y007DG08FI08Y00"
9020  $A+LENA="8GJ09IK09JL09KM0:LO0:Z00:MP0;O
      R0;Z00;PS0<RU0<Z00"
9030  $A+LENA="<SV0=UX0=Z00=>V0?BEHNQTW"
9040  RETURN
10000 PRINT'"  YOUR MISSION IS TO TRAP THE"'
10010 PRINT "EVIL SORCERER AND RETURN THE"'
10020 PRINT "MAGIC CHALICE."'
10030 PRINT "YOU HAVE BEEN GIVEN A MAGIC"'
10040 PRINT "STAFF WITH 500 UNITS OF MAGIC."'
10050 PRINT "USE IT TO OVERCOME THE"'
10060 PRINT "HAZARDS HIDDEN IN THE WHITE"'
10070 INPUT "BARROWS.  HIT RETURN TO
      BEGIN."$Q;PRINT$12
10080 RETURN
```

The ATOM BASIC program, conversion notes should be studied before starting translation to other systems.



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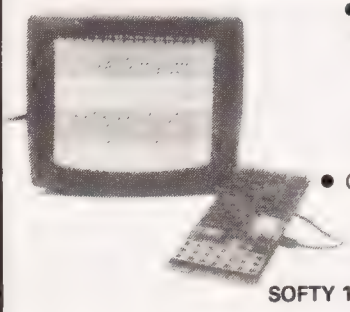

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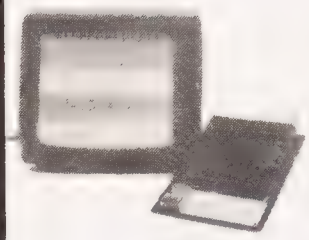

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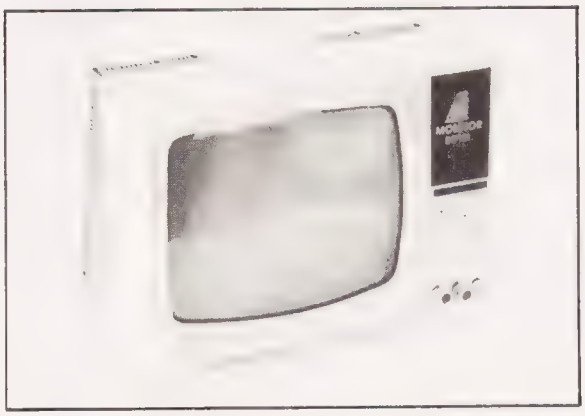

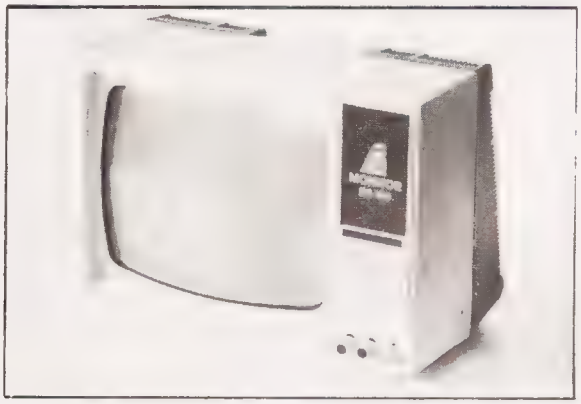

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Dear Sir,

I bought a CBM 4016 (PET) about two months before your September edition came out. Inspired by Mike James' article and being fairly competent with a soldering iron I decided to upgrade to 32K. I opened my PET and to my horror (and naughty words) I discovered four 6 mm holes drilled in the board.

After discussions with my retailer he suggested that I hard wire between IC socket pins those tracks affected by the PCB mutilation. The PCB is very similar for both blocks of RAM and it is fairly easy to trace where tracks should go.

I did this and for a grand total cost of £11 I now have a 32K PET — Take that, Commodore!

If this is a typical Commodore sales technique beware all ye potential VIC owners.

Yours sincerely,
J R Appleby
Durham.

Dear Sir,

Recent changes in the use of our clubroom have meant that the Cornish Radio Amateur Club's Computer Section now meets on a different evening to that previously published. The time is now 7.30 pm at the SWEB Social Clubroom, Poole, Redruth on the third Monday of each month. New members are welcome and should contact me at 24 Mitchell Road, Camborne, Cornwall TR14 7JH.

Yours faithfully,
Bob Reasons.

Dear Sir,

Your readers in the Aylesbury area might be interested to learn of the formation of the Aylesbury ZX Computer Club. The club plans to hold regular meetings at Aylesbury College on the first Tuesday of each month at 7.30 pm. While the club is based on the Sinclair micros, anyone interested in microcomputing is welcome to attend.

For further details contact me on Aylesbury 630867, or just come along to the next meeting.

Yours faithfully,
David Nowotnik
12 Long Plough
Aston Clinton
Aylesbury, Bucks.

Dear Sir,

We are pleased to announce the formation of a local Apple Microcomputer User Group. The Group will serve the Cotswold Area and will meet at a venue yet to be decided.

The purpose of the meetings will be to exchange ideas and expertise and to enable us all to get more from our computers. There will be an opportunity to mull over any mutual problems, and, hopefully, find the solutions.

Everyone is welcome to come along and the ownership of an Apple Computer is not essential. Those interested in joining should contact me at the address below.

Yours faithfully,
J G King
11 Sheepscombe Close
Benhall, Cheltenham
Gloucestershire GL51 6BE
Tel: Cheltenham 37808
or 34772 (evenings)

Dear Sir,

Sometimes when programming the ZX80/1, it can be useful to be able to skip some program lines in order to check other lines.

A simple way to do this is to call down the line to be skipped, by using EDIT, index the cursor to the right until it is between the line number and the keyword, and enter REM. Newline will return the line to its place in the listing, but it will now be a REM statement and ignored when the program is RUN.

To re-enter the line to RUN in program, all that is necessary is to EDIT the line by rubbing out the REM.

Hardware enthusiasts of the ZX80 may be interested to note that IC12 pin 12 is connected to pin 2 of IC13, a point not marked in the published Sinclair circuit diagram — this is relevant to my article 2K EXTRA in the May issue, where IC13 pin 1 should be used instead of IC12.

Yours faithfully,
N J Petry
Weston-super-Mare.

Dear Sir,

I am writing to inform you of details of the Nottingham Micro-Computer Club, which is now about two years old. A mention of our club's activities would be welcomed or, when next you publish a list of similar clubs, we would ask to be included.

The club caters for those of all ages and levels of experience who are interested in or work with microcomputers, and we arrange regular lectures by visiting speakers. Meetings are held at 7.30 pm on the first Tuesday in most months, at the Friends Meeting House, Clarendon Street, Nottingham.

The subscription is £5 per 12-month period from the date of joining, with reductions for students and OAPs. Non-members, for whom a 50p entrance fee is charged, are welcome. Present membership is in excess of 100 and rising.

Yours faithfully,
G Jago
Press and Publicity Officer
1 Lucknow Avenue
Mapperley Park
Nottingham NG3 5AZ
Tel. (0602) 621453.

Dear Sir,

Would you kindly mention the West Herts 80 Users Group in your columns. Formed in January of this year we currently number 30. Membership is not restricted to Hertfordshire residents and many of our group are also members of the 'Harpenden Microcomputer Group' or the 'TRS-80 National Users Group'.

Meetings are held fortnightly at St Stephens Parish Centre located at Station Road, Bricket Wood just north of Watford.

New members of all ability levels will be warmly welcomed, including those who are only considering the purchase of a TRS-80/Video Genie.

For further details contact:-
Terry Bradbury
20 Spruce Way
St Albans
Herts.
Tel: Park Street 73633
or
Reg Smith
24 Sempill Road
Hemel Hempstead
Herts.
Tel: Hemel Hempstead 60085.
Yours faithfully
T R Bradbury.

Dear Sir,

As a regular reader of your magazine I was most interested in the article by R N Braybrooke on the differences between the TRS-80 and the Video-Genie (which I have). I had discovered the printer 'hang-up' problem and also discovered that port 253 held **part** of the answer. The article suggests that the problem is easily solved.

I have an unexpanded machine with an Epsom MX80 connected and on switch-on (if the printer is off) PRINT INP(253) returns 127. However, if the printer is switched ON and put ON-LINE then the port returns 63. If the printer is OFF-LINE then 143 is returned. Now the problem appears. If the printer is switched off, then INP(253) still returns 63. So one is unable to distinguish between the printer ON-LINE and POWER OFF. However, at least the system does not 'hang-up'.

I hope this is of interest and I would be interested in hearing if there is a solution to the complete problem.

Yours faithfully,
Alan Beattie
Kilmarnock.

Dear Sir,

I would like to echo Mr Andrew's comments (November issue) about the excellent PET lister program by Paul Williams.

I use an OKI Microline printer and experienced the same problem as Mr Austin with the absence of Carriage Return/line feed. I assumed that the wrong BASIC subroutine was being

called since normal LISTs work as expected. The 'PET Machine Language Guide' from Abacus gives C9E2 as the address in New ROMs for a CR/LF routine. Substituting this address for FDD0 does the trick and is obviously the easier answer to the problem. The chages are:-

7560 20 E2 C9
7597 20 E2 C9

Incidentally, the Microline will print arrows instead of the square brackets required around programmed cursor movements etc. The best substitutes are the { } characters. The changes required are:-

75E4 A9 7B
75FB A9 7D

Yours sincerely,
J T Hoskins
London SE19.

Dear Sir,
Mr Austin's problem with PET Lister and the MX80 could have stemmed from two sources:

1. With the original internal program, the response of the MX80 to CR and LF can be varied by the setting of internal switches and an external signal line. Switch 1/3 is set ON at the factory, and that suppresses automatic line feed when print is initiated by buffer full. Similarly, switch 1/2 is set ON, suppressing line feed in response to CR. (For best flexibility, we leave the switches alone and make sure all necessary line feeds are explicitly generated, as Mr Austin has done.) There is also the AUTO FEED XT (low) signal. If not connected, this is at a high level, suppressing automatic line feed. However, it can be held in the low (active) state by setting switch 2/3 ON. Alternatively, a switch tying pin 14 to earth externally allows more convenient control to be exercised, the action being as for switch 2/3.
2. Among a number of alternative programs which have appeared for use in the MX80, one is known to ignore 0D Hex as the CR code, which is extremely annoying if your program does not output LF, since printing only occurs with LF or buffer full. It has been suggested that 0E Hex is recognised as CR, but I don't wish to know that, having no desire to alter all my firmware and software to cope with someone else's error!

Properly programmed and set up, the MX80 is a fine machine, but some of the unsatisfactory alternative programs could easily give it a bad name. A wise purchaser should check that all normal functions, as documented, are working correctly before paying out his money.

Yours faithfully,
Don Thomasson.

Dear Sir,
With respect to Frederick Brown's letter in the October issue regarding computer 'Bulletin Boards', I would be obliged if you would inform your readers of the following correction.

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Electronic mail, library for downloading programs.
System Hours-Sunday 4.00pm to 10.00pm Other times possible by prior arrangement.

Needless to say the usage of the system is free, no connection time charge (except for the phone call) and no subscription fee.

When Mr Brown wrote to you the times quoted were correct.

Thanking you for your kind attention.

Peter Goldman
Surbiton.

Dear Sir,
It is hoped to re-start the COSMAC Users Group originally proposed by Jim Cunningham if there is sufficient interest. The group will cater for users of the COSMAC series of microprocessors, ie the CDP1802, 1804, 1805, and for computers using this processor such as the ELF, Edukit, etc. Anyone interested in joining the club should send a stamped addressed envelope for further details to me at the address below.

Peter Hibbs
54 Runnymede Avenue
Bournemouth
Dorset BH11 9SE.

Dear Sir,
I would be grateful if the columns of your magazine could be used to give up-to-date details of the TRS-80 EDUCATIONAL USERS GROUP.

Contact: *Dave Futcher — Head Teacher, Beaconsfield First and Middle School, Beaconsfield Road, Southall, Middlesex.*

What it has to offer: *Basically to support and encourage the use of the TRS-80/Video Genie in Education in the following areas.*

Software Library and Exchange: *The group has a well established library of Primary, Secondary and Administrative programs. Further Education programs have been promised. The library has over 50 programs available and it is hoped the library will eventually include programs from the following areas — Computer Assisted Learning, Simulations and Strategy games, Animations for classroom use, Classroom and School Management.*

Advice, Assistance and Help: *The group has a wide experience to draw on in Educational establishments but also it has the membership of the very successful National TRS-80 Users to draw on. Regional workshops take place throughout the UK and it is hoped to plan a National Education Workshop in the coming months.*

A Monthly Newsletter: *In the National TRS-80 Newsletter, space has been found for a regular Educational Spot and this will develop as a forum for Educational Users.*

Thanking you for your co-operation in this matter.

Yours sincerely,
David J Futcher
Head Teacher.

Dear Sir,
We would be grateful if you could mention the formation of the Z80 NAS TUG (Thames Valley User Group) in your magazine.

Our aims are to promote the use and development of NASCOM 1 and 2 systems, together with compatible products, and to provide further development of hardware and software. The group also supports the INMC although membership of that organisation is not essential.

We will publish a newsletter and are planning regular meetings in the Slough/Staines/Windsor areas.

It is hoped to produce a software library, the contents of which will be available at prices which will cover the reproduction.

For further information please write to me at the address below giving your areas of interest and details of your system.

Yours faithfully,
Mike Rothery
37 Eton Wick Road
Windsor
Berks

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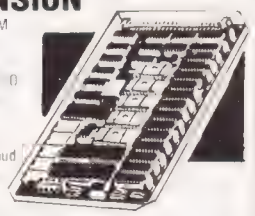

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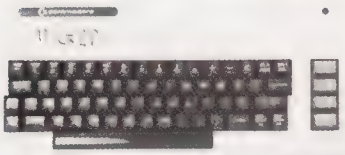

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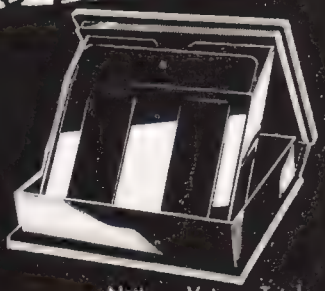

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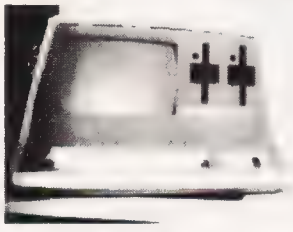

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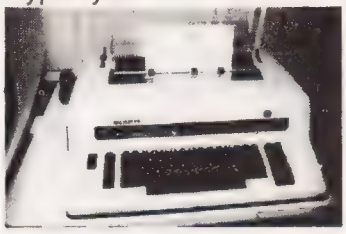

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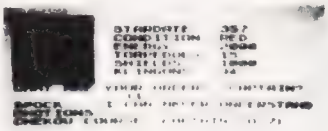

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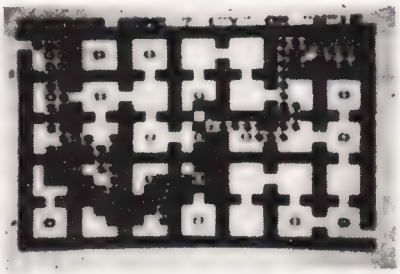

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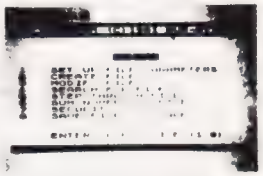

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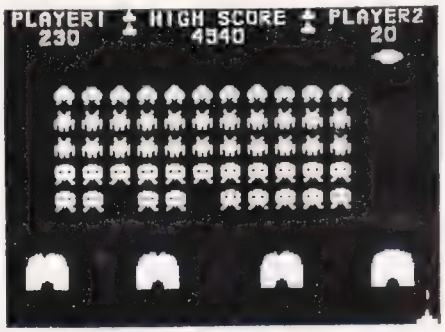

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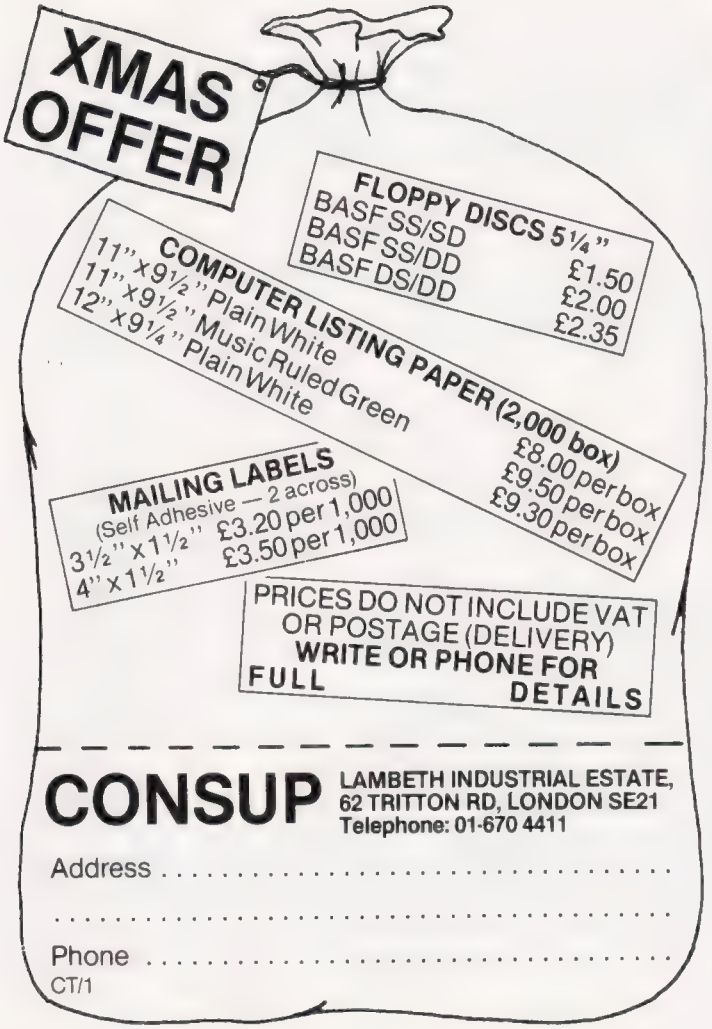

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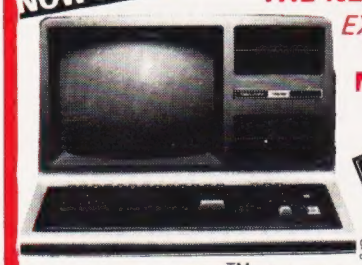

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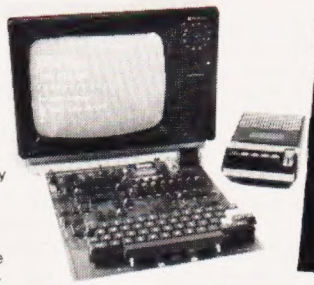

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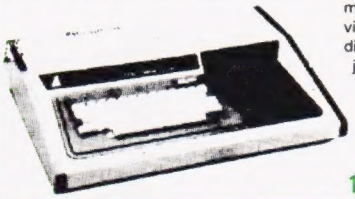

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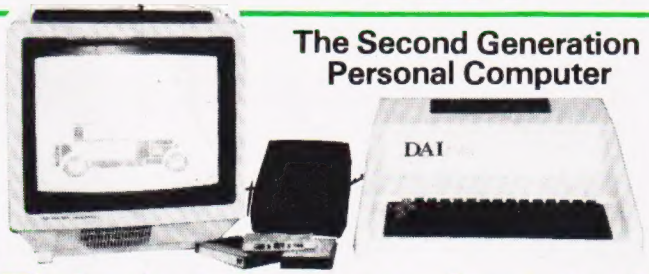

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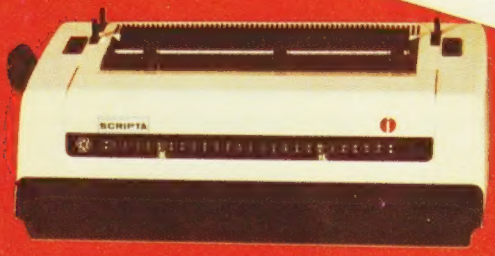

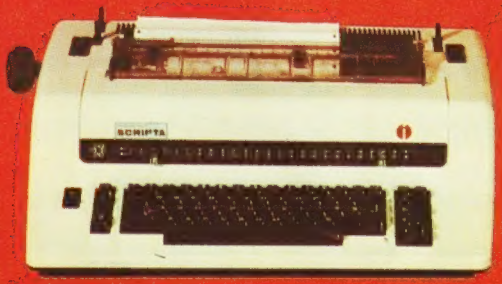

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